The

Geographical Journal.

No. 2. FEBRUARY, 1910. Vol. XXXV.

THE HISPAR GLACIER.*

I. ITS TRIBUTARIES AND MOUNTAINS.

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When I last had the pleasure of reading a paper before this Society in 1905, I showed a view of J. Petigax, C. Savoye, and myself standing under the reversed cornice, on top of the Alchori col, 17,000 feet, at the source of the Alchori glacier. We made the first ascent of this col with the hope of finding a caravan-passage on the north side to the Hispar glacier. Our disappointment at finding a cornice overtopping a sheer precipice of 2000 feet was mitigated by the wonderful view vouchsafed us of the north Kanibasar tributary of the Hispar, and a galaxy of magnificent peaks at its head. Some scenes spread before the explorer possess a strange allurement which remains fixed in memory, and that picture clung to mine, and I determined, if possible in the future, to visit the Hispar and its branches.

As I stated in my last paper, we had failed to find a caravan-passage to the Hispar on several occasions, both on three cols ascended from the Chogo Lungma branches, which, had they proved feasible, would have led to glaciers accessible to it, and on three points from the Alchori, which would have taken us over its great south wall. I said then I believed the only caravan-pass to it over the south watershed to be the Nushik La. Presently I shall have something more to say of this col as a practicable passage at the present day. Thus, having found we could not reach Hispar by a new, proper, mountaineer's pass, we decided

* Read at a Meeting of the Royal Geographical Society, December 6, 1909. Map, p. 224.

in the summer of 1908 to accept the commonplace, and approach it from the Gilgit road, called eighteen years ago by Knight the Siberia of Kashmir.

Intending to remain six to eight weeks in that region, do some detailed surveying of the main glacier, and particularly of the north tributaries not visited by Sir Martin Conway, it was decided to take a topographer with the expedition. Our friend M. Charles Rabot of Paris consulted Prof. J. Brunhes, of the Fribourg University, who recommended two of his former pupils, Comte Dr. C. Calciati and Dr. M. de Koncza, both of whom had had experience in glacial topography in the Alps. The two being desirous of the opportunity offered to do some Himalayan work, the services of both were accepted. Our old Italian guide of three Himalaya seasons, C. Savoye, and three Courmayeur porters, also accompanied us.

Two or three large caravans a year, only, being allowed to proceed towards the Pamirs, a permit from the Indian Government was necessary. Colonel Sir Francis Younghusband, resident in Kashmir, kindly undertook to arrange this matter, and we have to thank him for varied assistance and instructions given to officials both in Hunza-Nagar and later in Baltistan. Our friend the late Major G. Bruce, then political agent in Gilgit, was most kind in arranging six months in advance with the Mir of Nagar for a supply of grain and the contingent of coolies to accompany us on the glaciers. We were prevented from greeting and thanking him for his valuable aid by the inexorable decree of fate, and in Gilgit had only the mournful satisfaction of placing roses on his newly made grave.

The 240 miles of road separating Srinagar from Gilgit is no longer quite the Siberia depicted by Knight. It is a monotonous, dreary, and, at times, torrid enough stretch of country, but the road is a splendid tribute to the skill and energy of the engineers who built it, and who for years have seen to its constant maintenance, and the traveller has only to give the rein to his pony until he gets there, which is no special hardship to those accustomed to Himalayan travel. Two marches beyond Gilgit, at Chalt, the Hunza-Nagar country is entered, and here we were met by Sher Mohamed Khan, assistant to the political agent, who took charge of all arrangements for the further marches to Nagar. Just beyond Chalt, that famous peak Rakapushi, called by all Hunza-Nagar people Domani, bursts into view, a glorious 18,000 feet of sharp, gashed and séracked snow-slopes, culminating in abrupt ice-glazed pinnacles. To my mind it is a more impressive, grander mountain than Nanga Parbat. The Mir of Nagar was to have met us a few miles before the village, but we arrived six hours earlier than was expected, and were already inspecting the camping-bagh below the palace, when he came hurrying down with a numerous suite to welcome us. He is a slim, fair-skinned, intelligent-looking man, with brown eyes and aquiline nose, and quite

European in his dress. He brought his two bright-eyed little sons to see us.

The afternoon was passed in going over all the previous agreements for grain, sheep, and coolie-supply for the glacier work. He was to arrange for a constant band of sixty to seventy coolies, who every two weeks were to be changed off for a relief-corps.

The next morning, escorted to the outskirts of Nagar by the Mir, Wazir, and Khan, our large caravan in charge of a lambardar and military levy, left for Hispar village, 29 miles distant, whither the European agent and the topographers had preceded us by three weeks. Soon after leaving Nagar, the tongue of the Hopar glacier is crossed, and the narrow valley through which the Hispar river descends followed. It is encased on both sides by steep slopes composed of alternating strata of alluvium, sand, and gravel, interspersed with various-sized boulders, to a height of perhaps 2000 feet above its bed, upon which are superimposed tali of like materials fallen from peaks still higher up, through the whole thickness of which the river has cut its path, leaving the rough walls either vertical or descending to it in abrupt inclines.

These walls are broken at intervals by deep ravines washed out by floods, and avalanches of rock and sand constantly erode them, filling the air with dust. As the valley widens at times, a series of terraces of similar make-up are met with. The whole vale for many miles below Hispar presents a scene of utter desolation. The small path, often quite obliterated, and again barely wide enough for one's feet, winds up and down the barren spurs or over the edge of creepy precipices, to near the alluvial fan upon which Hispar village stands. At Hispar we stayed only long enough to reorganize our loads, interview the topographers who came down to meet us, and visit the Hispar tongue, which descends to 1½ mile above the village.

I would here refer to the Yengutsa glacier, the tongue of which, as well as that of the Hispar, was thoroughly examined by Mr. H. H. Hayden in 1906, on behalf of the Geological Survey of India. The Yengutsa tongue descends at present to within 2952 feet of the Hispar river, and Hispar village lies only about 754 feet east of it. Dr. Calciati made a survey on the scale of 1 : 20,000 with the "règle à eclimètre" of the part, including the tongues of the Yengutsa and Hispar, and so carried further the survey begun by Mr. Hayden.

As points of study for the Yengutsa, he and Dr. Koncza took the same two pyramids marked in black G.S.I., adding in red the initials B.W. and date of our expedition of 1908. Having previously possessed themselves of the facts reported by Mr. Hayden, their examinations show that this glacier remains about as he found it in 1906, manifesting only a small decrease in thickness and length. They report a recession of 98·9 feet, as measured carefully from the line of pyramids on either

side of the cañon. This figure has reference to the time of their departure only, the end of August, and they regard such a light retreat as due probably only to the summer contraction. It will be remembered that this is one of the glaciers examined by Mr. Hayden, which five years previous to his visit is said by the natives to have suddenly advanced with great rapidity, a distance which Mr. Hayden, referring to Sir Martin Conway's map, judges to have been about 2 miles. A further advance of this glacier might cause incalculable damage to the meagre wheat-fields of the inhabitants, who, as it is, find hard lines to subsist at all.

In regard to the Hispar, our topographers found the Geological Survey pyramids placed on both sides of the river at the tongue. Near the one on the right bank, they marked the red letters and date of our expedition on a large erratic boulder, repeating this marking on a polished rock near the Geological Survey pyramid of the left bank. They report the shrinkage in the end of the Hispar tongue as not exceeding 30 feet, so that the Hispar may be said to be stationary at present. By the end of August they noticed, however, that the depth of the tongue was much reduced, many large blocks of ice having fallen down and been carried away by the sub-glacial stream.

On July 4 we left Hispar. The weather having turned very fine, it was decided to ascend on the orographical left bank to the Haigatum glacier, and visit it and the Nushik La. This col—for I cannot to-day call it a pass—had a special interest for us, as in 1903 we had wished to cross it from Baltistan, but had been baulked in so doing by the Basha coolies, who had refused to ascend to it from the Kero Lungma. For many years it was spoken and written about as a passage for natives and even animals between Baltistan and Nagar, but when such reports as exist are sifted, there appears to be no history of any authentic crossing until 1892, when four members of Sir Martin Conway's party traversed it to the Basha valley. In 1861, Colonel Godwin Austen ascended from the Kero Lungma to its top, but did not descend it on the Haigatum side. Likewise, Major Cunningham followed later, reaching the summit, but, finding a cornice and steep ice-wall beneath it, retraced his steps. In 1896 Dr. A. Neve tried to cross from the Kero Lungma, but was obliged to turn back.

After camping beyond the entrance on the left bank of the Haigatum glacier, we ascended 600 feet on the arête above to examine the col. From here it was apparent that the sharp wall leading to the Nushik La was so difficult from its gradient and the kind of snow covering it, and so exposed to avalanches, which constantly fell from the overhanging snow-cornice running from end to end of its apex, that it would be tempting providence to attempt its ascent. More to the east, the slopes of a snow mountain, while in places steeper, schrund-cut, and overhung by great stratified cornices, led to a large white mamelon high above

FIG. 1.—PEAKS COVERED WITH HANGING GLACIERS ABOVE JUTMARU GLACIER.

FIG. 2.—WHITE MAMELON COVERED WITH NIEVES PENITENTES, 18,000 FEET, AT TOP OF ICE-WALL ABOVE HAIGATUM GLACIER, EAST OF THE NUSHIK COL.

FIG. 3.—CAMP AT 19,100 FEET ON FLANK OF BIAFO HISPAR WATERSHED PEAK, FROM WHICH ASCENT WAS MADE.

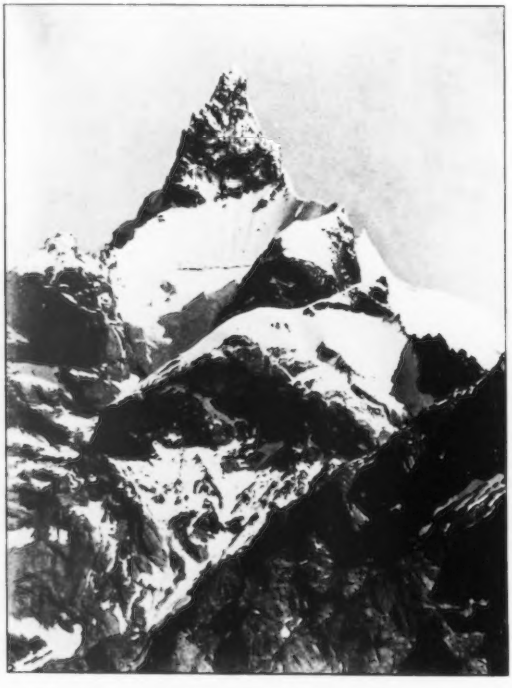

FIG. 4.—TELEPHOTO OF HIGH PEAK OVERHANGING THE JUNCTION OF LAK GLACIER WITH THE HISPAR.

the Nushik La, and this route we decided to try, with the guide and porters only. We should here reach an elevated brow in the depression, and overlook the region on both sides.

The levy and coolies, when asked what they knew of a pass from this glacier, replied that they had heard there was one, but had no personal knowledge of it. To ensure any reasonable surety to life, it would be necessary to start very early, in order to be down on the glacier again by noon, at which time the daily and continuous avalanche-cannonade started in from all slopes at the head of and above the east side of the glacier.

As there are other things to speak of to-night, I will not give a detailed account of the climb carried out from the camp, here seen near the source of the glacier. The dangerous ascent and descent was made between 2 a.m. and 12 noon. An hour or two spent on such scarps as seen in the view was a feature of the climb. Several times, whenever we dared to halt, the clinometer was used, and in each case, the angle of graduation of 60° being exceeded, failed to register. The slopes here and at other points were probably at an angle of 70°. Mr. O. Eckenstein, using Sir Martin Conway's clinometer, graduated to 46°, estimated an angle of $52\frac{1}{20}°$ on his ascent—obviously, as Sir Martin says, an error. The slants we ascended surpassed any such angle. At a point above the snow scarps we found again the interesting *nieves penitentes* first observed by us in Himalaya in 1906 in the Nun Kun. While not very high, from 18 to 24 inches, they were perfect specimens of this curious snow-phenomenon.

Next the white mamelon, height 18,000 feet, which overlooks the Nushik col by 1200 feet, is seen. Its north face presents a nearly perpendicular ice-wall, below which spreads a huge starfish-like bergschrund of unknown depth.

The route we took to the mamelon, the only one feasible at present, is strenuous enough for mountaineers, and cannot be regarded as practicable in any way for a loaded caravan. It would not have been possible to induce our Nagar coolies to follow us loaded up the appallingly steep and dangerous face we ascended. A descent can be made from the mamelon to the Kero Lungma, the ascent to the Nushik from Baltistan being quite possible for loaded coolies. The guide Zurbriggen appears, in 1892, to have ascended to a point well below the mamelon, but also east above the Nushik col, and thence crossed to the other side. In all respects the route, as he then found it, was, apparently, much easier than we found it in 1908, but that may be accounted for in the changed ice and snow-conditions in the last sixteen years. Such changes are known to occur in Himalayan passes, several instances of which might be cited. When one reflects on the mighty natural forces always at work in great mountain regions, particularly in the higher Himalaya, where wind, snow, and water are building up, tearing down, and washing out, with

a rapidity unknown in the Alps, this is not surprising. In our own experience of the last ten years in Asia, on revisiting certain places, distinct differences in the obstacles met with have been observed.

Above the mamelon east a fine snow-peak rose about 1000 feet in a series of slants separated by snow-terraces. This peak we climbed to within 20 feet of its apex, where from a small ice-ledge three ice-cornices rose straight above us, like the monster teeth of some petrified Himalayan mammoth of bygone ages. Savoye used his ice-axe for twenty minutes on the first one, and then reported that, owing to hard ice, it would take two hours to cut through them to the top. It was 10 a.m., and, in view of the dangerous avalanche-swept descent to the glacier, we decided to leave out the last 20 feet of cornices, for the mountain was really a *fait accompli*. We named the mountain (height, 19,000 feet) Triple Cornice peak.

I would here mention that our heights of peaks, passes, and camps, as on previous expeditions, were taken by boiling-point readings compared with simultaneous ones taken at a lower Government station—in this case at Gilgit—three times daily for us during the summer.

This view of the mamelon was taken on the descent. Scarcely stopping to breathe, the dangerous downward climb was made amid the boom of avalanches, which fortunately spared our party, and camp was reached by 12.30. To quote the opinion of a mountain-expert, Savoye remarked, *en route* to the lower camp, that he should not care to repeat that climb, as he had not felt easy in his mind from two in the morning until after noon.

The chief northern tributaries of the Hispar are the Lak, the Pumarikich, the Jutmaru, and the Kanibasar, and on the south the Haigatum and the Makorum. A survey with theodolite by Dr. Koncza, and with the "règle à eclimètre" of the Gaulier type employed in the French Army Topographical Service by Dr. Calciati, was made for us of these glaciers, and, in addition, many stereoscopic and panoramic views taken in connection with this work. I believe I am correct in saying that this is the first time that detailed glacial surveying by the methods employed of recent years in the Alps, America, and elsewhere, has been carried out in the Himalaya. They found the above glaciers join the Hispar by a regular slope without the intervention of a terrace, with the exception of the Pumarikish, which is connected by terraces. They report, as do we, no practicable passage between any two of the branch-basins.

Of our first exploration of the fine north tributaries, the Jutmaru and Kanibasar, respectively 9·3 and 5·6 miles long, I would say a few words as to their general character. In view of generally accepted ideas on nomenclature, that names known best to natives should be taken for glaciers and mountains, we have been forced to substitute

on our map the name Jutmaru for the glacier marked Kanibasar on Sir Martin Conway's, transferring the name Kanibasar to the higher branch, of which Sir Martin said in 1892 "there appeared to be no name." The Hispar natives accompanying the topographers, and Nagar coolies with us, whenever asked, distinctly stated that they knew these glaciers only by the names referred to, and in the order placed on our map.

As my province to-night is to mention mountain-forms rather than glacial features, I would say that both these branches are surrounded by high, picturesque but inaccessible snow and rock-peaks, often decked by hanging glaciers ending in such abrupt, savage ice-falls that it seemed as if the slightest earth-tremor would precipitate them in shattered ice-blocks to the main stream. The apices of these extraordinary peaks are in many instances festooned with fantastic double and triple cornices, perpetuating here on the frontier in snow-sculpture the weird figures, such as yalis and three-hooded cobras, of South Indian temple-architecture. Both glaciers widen near their sources into snow-basins, and we found, as did the topographers, the reservoir of the Jutmaru to be the more extensive. From that of the Jutmaru two steep tributaries branch east and west about 2 miles in length. These again end in rock-walls several thousand feet high, connecting more high peaks garlanded with furrowed and riven ice-falls, from which avalanches constantly fall.

The long longitudinal moraine-ridges on this glacier in places reach a height of 100 feet, while between them the white ice ascends gently, crevassed, presenting picturesque undulating bands. We found on this and on the Kanibasar many surface-streams, some difficult to ford, one on the Jutmaru being, when we crossed it, quite 50 feet wide. Our tallest man sank into it above the waist. It was coated with frozen slush, presenting a firm enough surface to enable us, by throwing ourselves flat, to crawl across by aid of our ice-axes placed in front.

Our duty as mountain-students was to climb cols for observation-points, but neither on the main glaciers nor on their branches could feasible slopes or ridges be discovered. The only one accessible to human feet was on the right bank of the Jutmaru, and this col overlooked a limited region of no geographical importance. This is the first branch on the left of the Kanibasar, the only one of any account.

To return to the Hispar. The only trees growing there at present are dwarf-willows. Cedars evidently formerly grew, as in a few places their dead trunks were found, but no living cedars were seen. The wood-growth limit is at about 14,500 feet, somewhat higher than on the Chogo Lungma glacier. The snow-line, on the contrary, is lower than we found it on the Chogo. After many observations we placed it on south slopes at not over 16,500 feet, while on northern ones it is, of course, considerably lower.

Passing by the still higher, equally interesting north branches of the Hispar, I must ask you to follow me on an ascent made from the highest base, called "Coolies' Paradise Camp," 15,900 feet, situated on the last moraine-ridge below the Hispar pass on the right bank. We have explored three out of four of the longest Himalayan glaciers, and on the Hispar found the greatest number of inaccessible peaks. I do not recall one on the north boundary high enough to afford a view of importance which is climbable, and certainly not one crowning the south snow-wall for 20 miles is even approachable.

To the north of the Hispar pass, and separated from it by 3 or 4 miles of ascending snow-fields and gashed ice-falls, rises a very sharp triangular pyramid-peak. The snows of its east side feed the Biafo and Snow lake; those of the south-west and west flanks contribute to the Hispar reservoir, hence the name, Biafo Hispar Watershed peak, which was given it. It is seen for 20 miles on the Biafo glacier, overtopping Snow lake to the west. From the Haigatum branch onward, always fore-shortened, it is visible from the left of the Hispar. The mountain had a singular attraction for me, for I knew that from its summit not only a grand view could be had, but one of much topographical interest. Three arêtes diverged from its pointed top, sweeping down precipitously 2000 to 3000 feet, of which the west and south ones looked impracticable of ascent, but the east had yet to be studied.

On August 1, with eighteen coolies under the lambardar, we left camp early, climbing the long, frozen slopes to the south of the pass. A day or two previous a new relay of Nagar coolies had taken the place of a bad lot who had returned, and we feared the new set would handicap the possible ascent of the mountain. After three hours' climbing, the peak came into full view, and we saw that the long ridge must be contoured, then a sharp ascent made to a high basin between the south and east shoulders. The caravan was still behind. We continued on to the base of a steep 800-feet wall, which, if surmounted, would bring us to the scoop between the arêtes, and render the peak probably within reach the next day. Making a solid zigzag path, we had climbed about 500 feet when the caravan arrived at the base.

The bearer called up that the coolies would not attempt the wall. We replied that they must. Then the lambardar harangued them, but in vain. Finally, Savoye went down to see what he could do. After he had talked a while, to our surprise, three of the loudest Nagaris attacked him with their spiked sticks. In self-defence he struck one of them over the back with his ice-axe, felling him to the snow. That settled the matter. They all subsided, and began to file slowly upward. This was the first time they had attacked the guide, and the first and only time a coolie was struck by our Europeans. The lambardar often used his stick on coolies; but that was the Mir's affair, not ours. Later, some of them reached the small snow-flat where we waited, while others

FIG. 5.—MOUNTAINS FORMING WEST WALL OF BIAFO GLACIER JUST BELOW THE POINT WHERE THE GREAT HISPAR-BIAFO WALL CHANGES ITS COURSE SUDDENLY FROM EAST TO SOUTH, ON WEST SIDE OF THE SO-CALLED SNOW LAKE.

FIG. 6.—HISPAR-BIAFO WATERSHED PEAK, 21,350 FEET, MRS. BULLOCK WORKMAN AND TWO GUIDES SEEN ON SUMMIT. PHOTOGRAPHED BY DR. WORKMAN FROM A NEIGHBOURING PEAK.

stopped short of it, allowing the porters to return and bring up their loads. We were, however, very glad to reach this spot, the height of which, later computed, was 19,100 feet. Savoye and one porter went off to examine the east shoulder, which was found impossible because of a fluting of cornices. The only solution was the south, much sharper arête facing the Hispar pass.

While still clear the next morning, the sky had a filmy look, indicating a storm before night, so all haste was made to secure the peak before a change came. With the guide and two porters, I left for this mountain; while later Dr. Workman and the third porter started for a lower peak east, overlooking Snow lake.

Crossing the intervening slopes, we ascended a steep snow-wall leading directly to the arête. This arête was ice-glazed, and at most 18 inches wide, ascending at an angle beyond 60° for some distance. To the right of it sank the wall just ascended, and sheer to the left a deeper seemingly endless abyss, filled with the gloom and mountain intangibility of early morning. Cutting each step, we climbed steadily for an hour to some gendarmes, which gave us a little rock-work. Beyond these a gentler gradient brought us to the base of a blue ice-wall about 15 feet high. Here we had some food. It was still fairly clear toward the Biafo, but toward the Hispar mist floated in, so Savoye at once began step-cutting on the wall, which we took sideways, each foot only half in a step. Below lay two-thirds of the mountain, a tortuous, precipitous mass, inviting to instant death should head or feet fail. The long, glistening arête was hailed again, rising sharper than ever, making every movement more arduous. Finally, this came to a climax, and the top was seen just ahead, a small cone turning over to the north in a cornice. Crossing an easier slope, then climbing a short narrow ridge, we arrived at a group of spiked rocks. From here, in five minutes, the cone was ascended, and, with the others holding the rope, I stood on the cornice, and saw one of the most remarkable and comprehensive panoramas I have beheld in Himalaya.

This single pyramid stands alone, with no near higher peak to mar the view on any side. Eastward, 5000 to 6000 feet beneath, lay Snow lake, its glacial branches spread like white fans, clearly defined, framed each by its border ranges. Beyond this swept, still further east, a great glacier fully 15 miles, behind the B 15 range, to the base of a high snow-wall which joins the east perpendicular slopes of the peak, 23,900 feet, which ten years ago we named Kailasa No. 2. Miles beyond, the Baltoro giants, K_2, the Mustagh Tower, Gusherbrum, and the Golden Throne caught the eye. Following south-east, the Biafo sank downward many miles, until lost behind dark mountain-flanks. Straight across, beyond the south ridge of the Hispar, I saw the wide void, beneath which, 2000 feet below, lies Cornice glacier, first discovered by us from the Col des Aiguilles at the head of the Hoh Lumba in 1903. The wall and mass

of peaks cutting it off absolutely from the Biafo on the east, and the great avalanched walls separating it from the Hoh and Sosbon glaciers on the south, were clearly seen, as were the cols we had climbed on these glaciers.

The western boundary formed by the Alchori mountains we followed up in 1903, and found no opening. I was thus able from this peak to obtain evidence confirming our observations made in 1903, that Cornice glacier lies in a deep hollow with no observable outlet at any point. We have examined its barriers on every side—and I believe it to be an example of what Sir M. Conway says cannot exist, an enclosed glacier. West, though clouds were rushing in, 20 miles of the Hispar were visible; and beyond it, partly snow-swathed, I recognized Pyramid peak on the Chogo Lungma and the sublime form of Domani. North of west stretched range after range of wild, unmapped mountains, beyond the frontier, and in the foreground of these rose what, from its charted position, appeared certainly to be the highest Kunjit peak No. 1, 25,492 feet. For a minute it was a glorious vision, but I recall it only as a stage phantom, for a dark purdah of mist fell between it and me.

I had seen wonders not of earth, the memory of which will cling while life lasts. Knight aptly called his book, 'Where Three Empires meet.' My eyes beheld at a glance on that day the whole magnificent mountain-landscape encompassing the meeting-places of three of Asia's greatest glaciers.

The other party was seen on their peak 1800 feet below, and from there Dr. Workman photographed us on the summit. A band of mist entwined itself about our cornice, and one-half the mountain world was lost in a sea of cloud. The others told later of the striking picture we presented: three black figures encircled by a cloud-wreath, not standing on a peak at all, but hung high in a heaven of incoming mist and storm.

We retreated to the rocks below, where instruments were noted and the record of the ascent left in a box, and, having hastily eaten something, began the descent, as an icy wind chased the mist backward, leaving a few steps of our path clear. It was a slow and dangerous descent through fog and cloud-billows, down the unending precipitous arête. But camp was safely reached, where the others greeted us with bravos of approval.

The height of the peak, since carefully computed, is placed at 21,350 feet. Savoye hoped it would be nearer our highest Nun Kun climb of over 23,000 feet, but, as I told him, we did not come to the Hispar to break records. This and the other climb are the first ascents to date of high peaks overlooking Snow lake, the Hispar pass, and the Biafo, and I am satisfied with all, except the storm that suddenly interfered with many photographs I wished to take.

Ten days later we crossed the Hispar pass to the head of Snow lake. I would here refer to Sir M. Conway's review of our book 'Ice-bound Heights of the Mustagh,' in the July, 1908, *Geographical Journal*, in which he says of Cornice glacier, just mentioned, "This glacier is a tributary of the Biafo." On his map he makes a large tributary enter Snow lake through its western wall at the point shown in this photograph. No break occurs in the wall here, and no glacier enters either here or for many miles further down, through the western Biafo wall. Our observations of the wall on its western side from Col des Aiguilles and mine from the Watershed peak, show conclusively that Cornice glacier is not a tributary of, and has no connection whatever with, the Biafo.

We wished to cross the Biafo and ascend the glacier east of B 15 to see if a caravan passage could be discovered to the Punmah glacier, but not a coolie could be persuaded to enter on the journey. Savoye and a porter went alone to the end of the east glacier, which they found closed. They then took a north branch, and ascended a steep col at its head, from which they saw a glacier flowing in the direction of the Punmah, as placed on existing maps, but the sharp col, heavily covered with new snow, was found quite impossible for coolies. By using snow-shoes on the glacier, and marching from 6 a.m. till midnight, they were able to make these observations. We ended our summer's exploration by descending the Biafo, reaching Askole August 27.

II. PROMINENT FEATURES OF ITS STRUCTURE.

By WILLIAM HUNTER WORKMAN, M.A., M.D., F.R.G.S.

Among the ice-bound heights of the Karakoram, in one of the most snowy of Asiatic mountain-regions, in a parallelogram bounded by 35° 40′ and 36° 20′ lat. N. and 74° 50′ and 76° 40′ long. E., lies a group of four of the world's greatest mountain-glaciers, three of which, the Biafo, the Chogo Lungma, and the Hispar, with many of their branches, have been explored from end to end by Mrs. F. Bullock Workman and myself.

Born amid the howlings of the tempest and the roar of the avalanche, in inaccessible fastnesses far above the habitations of man or animals, and fed by large tributaries themselves glaciers of the first order, these vast rivers of ice force their way downward through the intervals between precipitous mountains for many miles into the deep valleys below, where, succumbing to the heat there encountered, they gradually die out and disappear. The waters into which all of them are finally resolved find their way into that remarkable river, the Indus.

These great glaciers are not mere bands of snow and ice running smoothly from their sources to their tongues, but they are most

complicated structures descending in steep, broken ice-falls covered with splintered séracs or thrown up into huge undulations, ridges, and high hillocks, seamed by unfathomable crevasses, and bearing on their surface or within their substance an incredible amount of *débris* from the decaying mountains, whose crests they fringe with fluted snow-ruffles and whose flanks they rasp away and sculpture out in their downward progress.

From the similarity of their environing conditions these glaciers have many features in common, but each has also distinctive features sufficiently marked to render a comparative study of them all of engrossing interest.

We are considering this evening the Hispar glacier, the most northerly of the group. The tongue of this glacier is first encountered 2·1 kilometres (1·5 mile) east of Hispar village, at an altitude of about 3354 metres (11,000 feet). It is a broad, *débris*-covered, discoloured mass of ice, with irregular surface sloping down to the detritus-strewn valley-bed where it ends. A large torrent, issuing from an ice-cave on its southern side, has cut a passage for itself through the rock-*débris* to the valley below. This is joined at the extremity of the tongue by a smaller stream descending in a sulcus between the north side of the tongue and the ragged edge of a large alluvial fan radiating from a gorge in the mountains opposite.

From here the glacier ascends with a gentle gradient in a direction somewhat south of east for 59 kilometres (36·63 miles),* to the highest point of the Hispar pass lying at an altitude of 5335 metres (17,500 feet), where it meets the upper extremity of the Biafo glacier. Its average width above the tongue is about 3 kilometres, 1·95 mile. In the lowest 25 kilometres (15·53 miles) of its course it receives on its south, or orographical left side, six branches, three of them large, the highest being the Haigatum; but from here to its culmination in the Hispar pass no branch enters it on that side. On the north side nine branches, six of which are large, enter it at various points along its course. Most of these branches, but particularly the northern ones, are laden to an unusual degree with *débris*, the effect of which is manifested on the main trunk.

The mountains enclosing the Hispar, especially its upper half, as well as its branches, are high, greatly broken, very steep, and heavily covered with ice and snow. Their crests and summits are largely crowned with huge, overhanging cornices, many of them of great thickness and stratified in numerous layers. These, when they break

* Drs. Calciati and Koncza consider the length of the Hispar glacier to be 56·6 kilometres, which, as measured on their map, corresponds to the point where their route-line ends. By repeated altitude observations while crossing it, I found the highest part, or summit, of the Hispar pass to be 2·4 kilometres beyond or east of this point, viz. at 59 kilometres.—W. H. W.

away, give rise to avalanches of immense size, on account of which it is dangerous to approach the bases of the mountains, where avalanche-beds cover the edge of the glacier.

The southern barrier of the Hispar extends from the Haigatum glacier to the summit of the Hispar pass, a distance of 34 kilometres (21·1 miles), without a break. It consists of a high, continuous wall, rising at intervals into sharp peaks, the whole covered with snow, masses of ice, glaciers, and hanging glaciers, and surmounted by cornices, which frequently break loose and shower down avalanches on the glacier below. These avalanches score and chisel out its icy flanks into deep furrows, sharp ridges, battlements, and spires, which, combined with the frozen cataracts and flutings of the hanging glaciers, present a most weird and bizarre effect in the changing shadows which chase one another across the face of the wall, as the sun marks the hours in its westerly course. In our six expeditions in Himalaya, we have seen no ice-expanse that approaches it in extent, complexity, and grandeur. On account of the size and frequency of the avalanches falling from it, its base cannot, at any point, be approached with safety.*

For a distance of 24 kilometres (14·9 miles) above the tongue, the whole of the Hispar surface is broken into ice-hillocks separated by deep depressions and heavily coated with *débris* of every size from mud and sand to granite blocks 6 to 15 metres (20 to 50 feet) in diameter. Many of the hillocks have the form of symmetrical cones and pyramids, but many more have a perpendicular ice-wall on the one side and on the other slant back to the glacier at an angle of 45° or less. This formation is more pronounced and extends up the glacier to a greater distance than the similar formation on the Chogo Lungma, which has a length of 14·5 kilometres (9 miles), or that on the Biafo, which only reaches to a point about 5 kilometres (3·1 miles) above the end of the tongue.

A short distance below the entrance of the Haigatum branch a narrow band of smooth, white ice appears among the *débris*-covered hillocks, which stretches upward, becoming ever broader, till it merges in the white ice pressing down along the left or southern side of the glacier. On the north side the hillocks persist for 18 kilometres (11·5 miles) farther to the entrance of the Kanibasar branch. Above the Haigatum many of them are oblong in shape and are arranged in lines, their long diameter being coincident with the lines; but below the Haigatum such arrangement is less apparent. They vary in height from 15 to 70 metres (48·9 to 229·6 feet), but some, as will later be

* About 5 kilometres (3 miles) beyond the Hispar pass, the wall makes a sharp turn to the south and continues on, also unbroken, as the west wall of the Biafo glacier, for 24 kilometres (15 miles) farther. It thus forms a continuous barrier 64 kilometres (40 miles) in length, unpierced by a single glacier though extending through a region of snow and ice.

stated, exceed the latter height. Throughout the hillock-area, although the glacier carries such a vast amount of detritus, no well-marked median moraines are observable, the continuity of the moraine-material being destroyed by the broken condition of the surface.

From the edge of the hillock-area to the ice-falls below the highest part of the glacier the surface consists of fairly smooth, somewhat rolling, white ice, bearing only a moderate amount of *débris*. On the north side this section is only a few kilometres in length, reaching from the Kanibasar glacier upward; but on the south side it extends well downward toward the Haigatum branch.

The last and highest portion of the glacier forms the Hispar pass. This is a plateau of *névé* 5 kilometres (3·11 miles) long and about the same in width, covered with driven snow, unbroken by crevasses, and gently rising to a snow-ridge crossing its eastern end from north to south. The highest part of this ridge, near its termination in an ice-shoulder descending from the last snow-peak above the Hispar on the south, was measured by boiling-point readings, compared with simultaneous ones at the Government Station at Gilgit, at 5335 metres (17,500 feet). This ridge is the summit of the pass, and from it, on the east, one steps down upon the most westerly of the three heads of the Biafo glacier, between which and the Hispar it forms the line of demarcation. The gradient of descent of the Biafo from the ridge is much sharper than that of the Hispar.

North of the pass and east of Last Moraine branch of the Hispar lies a large snow-clad region, extending back 5 to 8 kilometres (3 to 5 miles), and sloping upward some 760 metres (2500 feet) above the Hispar pass. This is bounded and intersected by peaks and ridges, the highest of the former of which reaches an altitude of 6509 metres (21,350 feet), and forms a part of the watershed between the Biafo and Hispar glaciers. We entered this region at two points, and explored it to its northern enclosing walls. It sends down to the Hispar its highest northern branch, a large snow and *névé*-covered glacier, named by us the Névé branch. This region is one of the largest contributors to the Hispar stream, and the ice and snow from it break down into the latter in a chain of tumultuous ice-falls.

The reservoir of a glacier consists of a basin or basins usually enclosed by mountains and the highest portion of its own structure, which collect the snows that contribute to its formation. The dissipator is the lower portion, of varying extent, where melting exceeds the ice and snow-supply, and where, therefore, the glacier wastes away. The Hispar reservoir comprises the greater part of the region just mentioned, the whole of the Hispar pass to the highest summit-snow-arête, and the whole northern slope of the great southern Hispar mountain-barrier for a distance downward of 33·5 kilometres (20·8 miles) to the opening of the Haigatum branch.

FIG. 1.—THE FACE OF THE SNOW-REGION DIRECTLY NORTH OF THE HISPAR PASS AS VIEWED FROM A POINT ON SOUTH SIDE OF PASS OPPOSITE CENTRAL PEAK. THE PEAK IN CENTRE IS THE BIAFO HISPAR WATERSHED PEAK, 21,360 FEET (6509 METRES). SNOWS ON THE RIGHT (EAST) OF THE CENTRAL MASSIF DESCEND TO THE EAST INTO THE BIAFO GLACIER. THOSE IN FRONT AND TO THE LEFT (WEST) OF IT INTO THE HISPAR. WEST HEAD OF BIAFO DESCENDS BETWEEN THE SNOW-RIDGE AND ROCK-FACE AT EXTREME RIGHT. THE NORTHERN HEAD OF BIAFO PASSES NORTH BEHIND THE ROCK-FACE AND SNOWY RIDGE LEADING BACK FROM IT.

FIG. 2.—THE UPPER 19·3 KMS. (12 MILES) OF THE GREAT ICE-COVERED WALL FORMING THE SOUTHERN BARRIER OF THE HISPAR GLACIER. IT EXTENDS FROM THE HAIGATUM BRANCH TO THE HISPAR PASS, A DISTANCE OF 34 KMS. (21·1 MILES) WITHOUT A BREAK; THENCE 4·83 KMS. (3 MILES) BEYOND AS THE SOUTH WALL OF THE WESTERN HEAD OF THE BIAFO GLACIER TO A POINT, WHERE IT MAKES A SHARP BEND TO THE SOUTH, AND CONTINUES ON, STILL UNBROKEN, FORMING THE WESTERN BARRIER OF THE BIAFO GLACIER FOR 24 KMS. (15 MILES) FURTHER, WHEN IT IS PIERCED FOR THE FIRST TIME BY A LARGE BRANCH ENTERING THE BIAFO FROM THE WEST. THE TOTAL LENGTH OF UNBROKEN WALL IS ABOUT 64 KMS. (40 MILES).

FIG. 3.—A BORDER-LAKE NEAR THE JUNCTION OF THE JUTMARU WITH THE HISPAR GLACIER, IT IS ENCLOSED BY A LATERAL MORAINE AND THE MOUNTAIN-WALL ON THE RIGHT, AND THE HIGH SIDE OF THE JUTMARU GLACIER ON THE LEFT, FROM WHICH THE ICE-FRAGMENTS FLOATING ON THE WATER ARE DERIVED. THE STRATIFICATION OF THE BLACKENED GLACIAL ICE IS WELL SEEN. BEHIND ARE THE HIGH SNOW-PEAKS WALLING IN THE JUTMARU.

The powerful pressure from the north exercised by Névé branch, aided by that of Last Moraine and the large Kanibasar and Jutmaru branches, forces the glacier over bodily hard against its southern wall, which pours down a constant succession of glaciers, ice-falls, and avalanches over the line of contact, covering it so completely that the glacial surface, sloping upward into that of the wall, forms as intimate a connection with it as does that of any glacier with that of its initial reservoir. At no point in this long distance can any interval be seen between the edge of the glacier and the wall.

A remarkable circumstance connected with this is, that for 26 kilometres (14 miles) above the Haigatum branch the main part of the glacier opposite this ice-wall, excluding a comparatively narrow section adjoining the wall, serves as a dissipator, all loose snow, and, indeed over much of it, all *névé* being melted away in late summer. Also the northern edge of the glacier throughout this section, in complete contrast with the southern edge, has so melted away that it lies at a considerable distance from the mountain-slopes, which themselves are at that season free from snow.

A peculiar feature of the Hispar, not observed on the Biafo or Chogo Lungma, is the great number of lakelets scattered over its surface, especially in the hillock-area. From any point somewhat raised above the glacier a dozen or twenty in the immediate vicinity may readily be counted. With their transparent water, of beautiful green or reflecting the deep blue of the sky, they flash in the sunlight like emeralds and sapphires from their setting of brown and grey. The great majority of them are merely collections or pools of water occupying the depressions between the hillocks; but some of the larger are highly picturesque, their cleft, scarred, and banded ice-barriers, in places thickly covered with rock-*débris*, enclosing beautifully curved bays, between which graceful crystal promontories project, and their surfaces dotted with islets of ice or partly submerged boulders. These lakelets are seen even in the *névé*-area to as high an altitude as 4878 metres (16,000 feet). They are formed by the settling of the water resulting from surface-melting into the depressions. Very few of those observed were fed by streams even of small size, and few had outlets. There was a notable absence on the glacier of streams of running water, the greater part of the surface-water apparently finding its way into the lakelets. Few large streams, such as exist on the Biafo, were seen.

Besides these surface-lakes, many border-lakes and a few subglacial ones were found at the lateral edges of the Hispar and its branches, resulting from the damming of water by ice or moraine-barriers. Some of these, their surfaces flecked with miniature icebergs interspersed among projecting boulders, in their setting of mountain and glacier, formed pictures of great beauty. These lakes were more interesting to observe than to negotiate. On several occasions we were obliged to

cross the beds of border-lakes recently drained, when we had the pleasure of wading through soft, sticky mud, ankle-deep, that cleaved to our boots in great, unwieldy balls.

The existence over the lower two-thirds of the glacier of such a large number of surface-lakes implies an absence of crevasses, or, at least, the presence of very few, for, did any considerable number exist, the lakes either would not form at all or would be quickly emptied. This inference was shown by observation to be correct in fact. Notwithstanding the extreme irregularity of the surface, few crevasses of any size were seen in this area.

Crevasses are usually caused by steepness or irregularity of the glacier-bed, and are intimately associated with ice-falls. Only one series of ice-falls occurs on the Hispar, viz. in the section near its head, where it descends sharply from the Hispar pass to the level of Last Moraine glacier, into which section the northern portion of its reservoir tumbles, also in ice-falls. Here large crevasses occur, though many of them are not deep. From Last Moraine glacier to its tongue the Hispar descends in an even, regular stream with a gentle gradient. In the 20·5 kilometres (12·7 miles) from the upper edge of the Kanibasar junction to the lower edge of the Haigatum junction it falls about 305 metres (1000 feet) or 1 : 67 metres or feet. This, together with the absence of crevasses, points to the conclusion that the glacial bed is practically smooth.

Now, in the case of a simple glacier without affluents, with a smooth bed of uniform breadth and gentle gradient, we should expect to find its surface smooth, even if bearing moraine. How, then, does it happen that the surface of the Hispar, where both the last two conditions obtain, is so universally broken up, over the detritus-covered portions, into high hillocks separated by deep depressions? The answer to this question can only be found in the effect on the glacier of its branches.

The four moraine-bearing branches on the north side above the Haigatum, coming from high mountains, exert a tremendous pressure on the main stream, forcing it over bodily, as has been stated, against the ice-covered mountain-wall on the south side. Being prevented by the wall from yielding any more, and being compressed into the smallest possible space, the main stream resists further encroachment on the part of the branches.

Under such circumstances, what next happens depends on the resisting power of the ice to compression as compared with the pressure brought to bear upon it. If the former be greater than the latter, the branch simply turns in a curve into the space from which it has pushed the main glacier, and moves downward side by side with the latter with a smooth surface, as is the case with the large Haramosh branch after its junction with the Chogo Lungma. If, however, as is the case here, the

pressure is greater than the resisting power of the ice, the ice is obliged to yield still farther, which it does in the direction of least resistance, *i.e.* toward its free surface, and is folded up into ridges and protuberances having a size and height proportioned to the excess of pressure over resistance, till an equilibrium is established.

Owing to the conditions existing at the lines of impact of the branches upon the main stream, the direction of pressure varies at different points, and in consequence ice-hillocks, many of them of great size, are formed instead of long ridges. While some of these, as already stated, take the forms of symmetrical or oblong cones and pyramids, their contours probably rounded somewhat by the heat of sun and air, the shapes of others in the hillock area indicate that, under the severity of the pressure, the ice composing them bursts asunder and forms a fault, one portion being crowded high above the other as a perpendicular ice-cliff shelving back to the glacial surface on the farther side. This process occurs most markedly in the upper layers of the ice, the lower ones, so far as can be seen, remaining in solid contact without the development of deep crevasses.

The hillock-formation first appears at the line of junction of the Kanibasar branch with the main stream, developing in the Kanibasar area as it moves downward. At the entrance of the Jutmaru it becomes more accentuated, the pressure here being evidently increased, and the broken surface extends upward into the Jutmaru itself for some 3 kilometres, nearly 2 miles, while it also spreads out laterally farther over the Hispar, encroaching still more on the area occupied by the white ice. The pressure is augmented at the junction of each succeeding lower northern branch.

The entrance of the Haigatum and the five lower branches on the south side now introduces a new factor of active counterpressure, thereby enormously increasing the compressing force to which the ice is subjected. The effect of this manifests itself immediately. The white ice, which after the junction of the Jutmaru branch narrows rapidly, and opposite the Haigatum is reduced to a slender tongue, just below this point is completely overwhelmed and disappears from view. From here to the end of the Hispar, a distance of 24 kilometres (14·9 miles) only a chaos of detritus-covered hillocks is seen. These, which higher up were more or less arranged in lines, are here thrown into disorder by the variety of opposing forces. They are also crowded up to a greater height, and, opposite the Makoram branch, their apices rise 85 metres (278·8 feet) above their bases.

The similar, though much less pronounced, formation existing at the lower ends of the Chogo Lungma and Biafo glaciers appears only after the lateral pressure on their streams has been increased by the junction of large branches and narrowing of their beds. A reach of typical hillocks was found at the middle third of the Biafo, in the area of a large

western branch entering at that place, but it disappeared lower down. At and below the junction of the Alchori glacier with the Kero Lungma, the former descending rather sharply on the latter, a similar crowding up of the surface was observed in 1903, the elevations presenting some of the largest, highest, and most impressive, ice-slants I have anywhere seen on a glacier. The hillocks here were composed of ice bearing but little moraine-material.

A notable instance of this formation exactly paralleling the Hispar hillocks, and by no means yielding the palm to them in size or height, as it was larger than any of those observed on the Hispar, was mentioned by me, in a paper before this Society in November, 1907, as met with in the Nun Kun.* This was only a single hillock, but its genesis by pressure was all the more apparent on that account. It occurred at the line of impact on the Shafat glacier of a short branch falling some 2750 metres (about 9000 feet) directly from two high peaks. It was covered thickly from bottom to top with black detritus, while the side of the Shafat, which was opposing its advance, was clothed with red granite detritus, so that the area occupied by each was clearly marked. This instance and the hillock-area of the Hispar were particularly favourable to the study of this process, as it was not complicated by the presence of ice-falls or séracs in either case.

The pressure of most of the branches at the line of their first contact with the Hispar acts upon the latter in a direction nearly or quite perpendicular to its axis. As the branches, under the pressure from behind and the resistance of the main glacier in front, turn in great curves toward the west and align themselves with the main trunk, the pressure is transmitted around the curves so as to act, finally, at right angles with its former direction, or parallel with the glacial axis. Hence it follows that the lateral displacing power of the branches on the glacial trunk is greatest at or shortly below the line of their impact upon it, diminishing as the angle of contact, in their passage around the curve, becomes more acute, and becoming practically nil, when they have fully aligned themselves with the glacial axis and become constituent columns of the main trunk.

An interesting circumstance connected with the pressure of the branches, especially of those above the Haigatum which have no opposing branches on the south side, is, that, when an equilibrium has been established by the yielding of the main stream, the compression and folding of the ice, and the pushing up and faulting of its upper layers into irregular projections, and the branch has turned into and occupied the space from which it has displaced the main glacier, the compound glacier thus formed moves downward, until joined by the next lower branch, without exercising any perceptible return lateral pressure toward the side from which the branch entered. This is seen in the fact that,

* *Vide* the *Geographical Journal*, January, 1908, p. 17, illustration.

after the branches have turned downward in the direction of the glacial axis, their free edges, though broken and greatly serrated, rising perpendicularly high above their beds run in straight lines at considerable distances from the former lateral moraines or from adjoining mountain-walls to the junction of the next lower branch. The same was observed to as marked a degree on the Biafo.

Besides the absence of typical median moraines in the hillock-area, where moraine-material is most largely found, such moraines are rather feebly marked over the remainder of the glacier. A few small ones extend out from the south ice-wall just above the entrance of the Haigatum and from the junctions of the Kanibasar and Last Moraine glaciers, but otherwise the remarkable, highly developed moraine-formation existing on the Chogo Lungma is wanting.

Not so, however, with lateral moraines. On the south bank of the glacier below the Haigatum and along the whole of the north bank as far as Last Moraine branch, gigantic, ancient, primary moraines overgrown with vegetation and dwarf-willows exist. The highest of these are found on the north bank between the Lak glacier and the end of the Hispar, where the ridges of some of them, as measured by Drs. Calciati and Koncza, stand 120 metres (393·6 feet) above the present surface of the ice.

Between these and the glacier more recent secondary moraines, some of them of large size, are seen at various places. On the west bank of the Haigatum, just above its entrance into the Hispar, where we camped, five lateral moraines were found, one below another, the fifth, by no means a small one, being still in the process of formation. The highest recently formed lateral moraine adjoining the ice is situated on the north side of the Hispar, just below the junction of the Lak glacier. Its height was measured at 40 metres (131·2 feet).

The Hispar and its larger branches, and also the Biafo at certain points, are, at present, actively engaged in building lateral moraines. At the edges of these glaciers great, ragged, perpendicular ice-walls rise high above the glacier-bed, their summits as well as their substance heavily loaded with *débris*, which is constantly showered down, often in cart-loads, upon the moraines at their bases. At some points the moraines can be seen to grow day by day, and even hour by hour. As these walls move downward in straight lines, they apparently exert no lateral pressure on their moraines, so that there is no question as to their forming moraines by pushing or ploughing up ground-moraine-material, and I saw no evidence that such was pressed out on their sides by their weight. The moraines appeared to be wholly built up by the deposition of the *débris* borne on the glacial surface, as well as in the crevasses and substance of the ice-walls.

Some fine examples of intraglacial moraines cropped out in places on the glacier-edges, composed of detritus which had fallen into and filled

large crevasses. The capacity of the Hispar as a moraine-builder appeared to be exhausted before its ice reached the extremity of its tongue. In contrast to the large lateral moraines higher up, the terminal moraine-formation was not marked, only a small moraine existing in front of one section of the tongue.

Névé and glacier-ice are composed of strata or bands, which represent the snow-accumulation of successive seasons in the reservoir. At the sources of a glacier these are of considerable thickness, and overlie one another in horizontal or gently curving layers corresponding with the conformation of the terrain on which they rest. In a glacial trunk they are compressed, often into thin ribbons, and their edges may be tilted to any angle with the horizontal. They may also be curled and twisted into serpentine folds.

A great glacier is not the best place to study the relation of banding in the trunk to *névé*-stratification in the reservoir. In the complexity of currents, the breaking up into ice-falls and seracs, the displacements, the regelation, the conditions of pressure, folding, and torsion, and other accidents to which the ice of a glacier is subjected, the difficulty of tracing the relation of the final structure of a given mass of ice to that of the *névé* in which it originated, after the great distance it may have travelled from its source of origin to the place where it is observed, is obvious. Indeed, it is marvellous that, considering the vicissitudes it has undergone, the ice near the tongue of a 50-kilometre (31-mile) long glacier should retain such perfect stratification as it often exhibits. This subject is more advantageously studied on short uncomplicated glaciers.

On all exposed surfaces of the Hispar ice-falls, as on similar surfaces elsewhere, the *névé*-stratification was well marked, the strata being horizontal or somewhat curved. So on exposed ice-surfaces at all points of the glacier, even to the extremity of the tongue, stratification was visible; but the strata ran in every direction according to the conditions to which the ice had been subjected on its downward journey. Perpendicular strata were common. In many instances they were curled and twisted into curious patterns, while in one large ice-ledge projecting from the extremity of the tongue they were as horizontal as could be found in the level *névé*. Over the greater part of the end of the tongue stratification could not be observed owing to the discoloured and detritus-covered condition of the ice.

Not one of the grassy, flower-sprinkled maidans described in connection with the Chogo Lungma and Alchori glaciers was met with on the Hispar.* The mountains rise too abruptly from the glacier to afford any space for these. One such maidan was found at the junction

* *Vide* 'Ice-bound Heights of the Mustagh,' pp. 179, 352, 361; and the *Geographical Journal*, March, 1905, pp. 252, 253.

FIG. 4.—A GLACIER-TABLE OF UNUSUAL SIZE MET WITH ON THE LOWEST THIRD OF THE BIAFO GLACIER AT AN ALTITUDE OF ABOUT 3660 METRES (12,000 FEET). THE ROCK-BOULDER WAS 5 METRES (16·4 FEET) LONG, THE ICE-PEDESTAL 3·8 METRES (12·46 FEET) HIGH, AND THE HEIGHT OF THE WHOLE 5·5 METRES (18 FEET). A TABLE WITH MUCH LOWER PEDESTAL SEEN IN DISTANCE AT LEFT.

FIG. 5.—MUD-COVERED NIEVES PENITENTES, THICK DÉBRIS, VARIETY VI., IN CENTRE OF BIAFO GLACIER; COATING THICKEST AT APICES. PYRAMIDS ARRANGED IN TWO LINES. LARGEST 70 CENTIMETRES HIGH. HIGH MEDIAN MORAINE SHORT DISTANCE BEHIND THEM.

FIG. 6.—FOUR OF THE DÉBRIS-COVERED HILLOCKS OF THE LARGER VARIETY STANDING IN A LINE IN THE CENTRE OF THE HISPAR GLACIER AT A DISTANCE OF 29 KM. (18 MILES) ABOVE THE EXTREMITY OF ITS TONGUE. THE HEIGHT OF HILLOCKS LIKE THESE VARIED FROM 15 TO 85 METRES (48·9 TO 278·8 FEET). THE ONES HERE SHOWN ARE AMONG THE LARGEST.

of a branch of the Jutmaru with that glacier, and utilized for a camp. This was of alluvial formation, and had, in the not distant past, been the bed of a border-lake, which had mostly silted up through the deposit of mud poured into it by the streams from the glacier above.

Nieves penitentes were met with, widely distributed, on the Hispar and its branches, on the mountain-slopes enclosing them, and on the Biafo and Skoro glaciers, occurring under a variety of conditions. Careful observation of the material presented, many times repeated, afforded confirmatory evidence of the truth of the views relative to the development of this formation expressed by me before this Society in November, 1907,* and also added new facts regarding it, which throw definite light on this hitherto obscure and little-understood question, in regard to which opinions have differed so materially.

The *nieves penitentes* studied by myself in the Nun Kun in 1906, though scattered over a wide area, appeared to be everywhere of the same kind, and due to the action of one and the same set of causes. The diversity of opinion, however, regarding the mode of development of *nieves penitentes* expressed by various observers, many of whom are men trained in glaciological science, induced me at that time to suspect that more than one set of conditions were concerned in the production of this phenomenon, and that different observers had met with *penitentes* that were determined by different causes, the formation of which they endeavoured to explain upon a common principle, upon which they, naturally, were unable to agree. This view has since been borne out by the various forms of *nieves penitentes* met with in the Hispar region in 1908.

Among the variety of views that have been advanced, observers have practically agreed that one factor essential to the production of *penitentes*, and according to some the only one, is the unequal melting of *névé* under the application of heat in some form, principally that of the sun. Having become convinced by my observations in the Nun Kun, that the action of heat is simply to melt the softer and less resisting faster than the denser and more resisting parts, this action being identical in all cases; and that, for the development of *nieves penitentes* under the application of heat, an antecedent or concomitant differentiation of *névé* or ice into alternate areas or centres of unequal density is also necessary, with the profusion and variety of *penitentes* spread before my eyes in the Hispar region, I endeavoured to solve the problem by directing my attention to the study of the circumstances that might produce such differentiation, with the result that I was able to recognize eight distinct varieties of *nieves penitentes*, the first including three sub-varieties, classified according to observed antecedent causes other than

* *Vide* the *Geographical Journal*, January, 1908, pp. 17–22; also the *Alpine Journal*, May, 1908, pp. 139–148.

melting. This being, so far as I know, the first attempt at classification of *penitentes* that has been made, and based only on what was actually seen, it is quite possible that further observation may disclose additional varieties.

The varieties observed were (I.) The avalanche variety with three subdivisions. (*a*) It was found that in the case of avalanches composed originally of hardened *névé* falling from heights above upon sloping surfaces, over which they travelled for considerable distances, the coarser constituents or blocks showed a tendency to arrange themselves in lines, while the more finely divided and pulverized portions took the form of ridges, both lines and ridges being parallel to one another, with a direction coincident with the incline of the slope and the course of the avalanche. These ridges contained at short intervals centres denser than the rest of their substance, formed between pressure of moving snow behind and resistance of that in front. The action of sun and heat on these avalanche-beds, thus differentiated, had developed *penitente*-pinnacles of various forms and sizes by shaping the *névé*-blocks and melting away the softer portions of the ridges.

(*b*) Where snow-avalanches without a primary, perpendicular drop had slid down over *névé*-slopes, parallel ridges containing centres of denser *névé* were formed, which centres under heat developed into *penitente*-pinnacles of pyramidal type and moderate size, both ridges and pyramids orienting with the slopes and courses of the avalanches.

(*c*) Where new, soft snow at high altitudes of upwards of 5800 metres (19,000 feet) had slid down very steep slopes, and lodged without travelling forward after striking, *nieve*-pinnacles with serrated, feathery apices were developed by melting. These stood in rows largely transverse or diagonal to the direction of fall of the avalanches, though often coincident with it. Although their material was softer than is usual with other *nieve*-forms, denser centres constituting the bodies of the pinnacles were demonstrable. The nature of the avalanche itself thus seems to condition the type of *penitentes* developed on its bed.

II. Subsidence variety. On beds of old, consolidated *névé* covering sloping surfaces not sufficiently steep for production of avalanches, subsidence of their component snow gave rise to straight-edged, longitudinal ridges with denser foci, which had developed into pyramidal *nieve* of medium size, both pyramids and ridges orienting with the inclines of the slopes.

III. Wind-conditioned *penitentes*. Extensive *névé*-surfaces with gentle inclines, both on glaciers and mountains, were covered with parallel ridges running in every direction according to the incline of the slopes, with which their course always coincided. The tops of these ridges bore *penitente*-pyramids of medium size denser in structure than the *névé* between them. These ridges and pyramids, like those on the Shafat glacier, occupied surfaces swept by wind and not exposed to

avalanches. The *névé* composing them was not so old or dense as that of the subsidence-variety, and the ridges were more wavy in outline.

The next four varieties, each presenting distinctive features of its own, depend for their formation on the deposition of detritus of various kinds on a glacier, the detritus, according to its nature, causing the ice beneath it to melt by absorbing and transmitting the sun's heat, or protecting the ice beneath it from the action of heat while the glacial surface around melts away, thus giving rise to *nieves penitentes*.

IV. Thin detritus variety. Over large areas of the Hispar and Jutmaru glaciers *penitentes* were met with varying from a few centimetres to 2 metres (6·5 feet) in height, the intervals between which were occupied by oblong pools with perpendicular walls often a metre or more in depth, the bottoms of which were covered with thin layers of finely divided earthy material, sand, gravel, or thin pieces of shale. These pools were arranged with great regularity, their long axes orienting mostly east and west, as did those of the *penitentes* between them.

Here the *penitentes* owed their existence to an antecedent deposit of detritus, probably mostly through æolian agency, in parallel wavelets upon smooth surfaces of the glaciers. These wavelets, absorbing and transmitting the sun's heat in virtue of their dark colour, caused the rapid melting of the ice beneath them, thus forming the pools at the bottom of which they lay. The pinnacles of ice left standing white and clean between them were moulded by heat into *nieves penitentes* of typical shape.

V. Glacier-table-variety. This was seen in abundance on the Hispar and branches, and on the Biafo and Skoro glaciers, below the limit of *névé* along the courses of moraines, where multitudes of boulders and glacier-tables covered the surface. Glacier-tables are formed by the melting of a glacial surface around the resting-places of large boulders, leaving the latter supported on pedestals composed of ice, which, protected from the sun's rays by the boulders, has remained unmelted. As the upper extremities of the pedestals become bevelled by melting, the boulders no longer sit level upon them but begin to tilt, and, as the bevelling becomes more accentuated, they finally slide off on to the glacier, leaving the pedestals standing as ice-shafts 1 to over 2 metres (6·5 feet) high, which are further sharpened off into *nieve*-pinnacles by heat. In some cases the shaft is developed into a fully formed pyramid before the top slides off. In other cases it is sharpened off after this event. These *penitentes* were found single, in groups, and in lines, in the two latter cases being developed from pedestals of several glacier-tables standing together, or from several hardened columns formed beneath very large boulders. Their orientation was determined by the shape and character of the boulders to which they owed their existence.

VI. Thick detritus-variety. This was seen mostly on ice below the

névé-line also along the courses of moraines, orienting in every direction irrespective of inclines. The pinnacles were met with, a few in a place or in large numbers, arranged in great part in lines, covering plain ice-surfaces, slants, crests, depressions, and even the exterior of séracs. They were invariably coated with mud, sand, or gravel, most thickly over their apices and the ridges running out from them. They consisted of dense, crystalline ice destitute of air-bubbles, and much harder than the melting aërated ice around. They owed their origin to the deposition on the glacier of patches of mud, sand, or gravel, which, like the boulders of the glacier-table variety, protected the ice beneath them from the heat of sun and air, that melted away the surrounding ice, leaving them as *penitente*-pinnacles, always of pyramidal type, and often 2 to 3 metres (6·5 to 9·75 feet) high, one of 10 metres (32·8 feet) being found.

VII. Lacustrine or composite variety. This was found on old beds of consolidated *névé* adjoining glacier-lakes, in the mud-laden waters of which they had been submerged. The pinnacles were triangular and quadrilateral pyramids, 30 to 40 centimetres (12 to 16 inches) high. They were arranged in regular rows, were connected with one another by ridges, and oriented with the slopes they stood on. They were coated with mud, most heavily over apices and ridges. In this case the differentiation into pyramids and depressions probably occurred through the agency of wind or subsidence and sun antecedently to their immersion in the lake; but the action of water may have accentuated the process, and it deposited the mud in consequence of which their further development, after subsidence of the water, would proceed on the lines of that of variety VI. Similar *nieve* was seen on beds of hardened *névé*, which had been submerged by muddy torrents resulting from the bursting of glacier-dams.

VIII. Sérac variety. Many tall, slender séracs were seen on ice-falls modelled by heat into cones and pyramids of giant size displaying all the features of ordinary *nieves penitentes*, even to hoods, and evidently fashioned in the same manner. Also on their surfaces small projections and irregularities were sculptured into *penitentes* of usual size and shapes.

The extended observations, which have made the above classification possible, lead me to the conclusion that *nieves penitentes* are developed by the action of heat, from whatever source derived, upon *névé* in which ridges containing centres or foci of hardened snow, and sometimes such centres independent of ridges, have been formed by avalanches, subsidence or wind, the size and shape of the centres determining the size and shape of the resulting pinnacles; and also upon *névé*, but more notably upon ice on which detritus has been deposited under circumstances described, or which has been disrupted into comparatively slender fragments or séracs. In all cases heat melts away the softer and less protected portions more rapidly than the harder and better protected ones, leaving the latter standing as *nieves penitentes*. The sculpturing

process may, in rare instances, be assisted by the action of water as in variety VII.

NOTE.—For a detailed consideration of this subject, which is only indicated in a very condensed form here, *vide* a paper entitled "A study of *Nieves Penitentes* in Himalaya," Paper No. 2, by William Hunter Workman, M.A., M.D., in the *Zeitschrift für Gletscherkunde*, Band III., Heft. IV., May, 1909. Also for a somewhat less detailed description *vide* "Peaks and Glaciers of Nun Kun," by Fanny Bullock Workman and William Hunter Workman, pp. 163–199.

Sir MARTIN CONWAY: Before making one or two remarks on this interesting paper, I should like to return my very cordial thanks to Dr. and Mrs. Workman for the delightful pleasure they have enabled me to enjoy to-night, in revisiting, by aid of their beautiful photographs, this perfectly glorious region, second to none of the mountain regions of the world, for beauty and interest. Mrs. Bullock Workman referred to the nomenclature of the glaciers of the Hispar basin. Of course, travelling very rapidly through a country, as a first pioneer must do, it is not possible to do more than collect such names as the natives present give. My experience is that it is very difficult indeed to place much reliance upon those names. Certainly the glacier which was called Kanibasar on my map appears to be next to the one called Kanibasar on Dr. and Mrs. Workman's map. I have no doubt they may have obtained a more correct location for the name; but when I was there, only a few of the oldest coolies had been up the Hispar glacier before, and none of them were quite sure of where some names should be located. Names float about in those very remote places, and, as a matter of fact, they may not become firmly fixed until the map-maker comes and fastens them down. I found a similar uncertainty as to the names of some of the tributaries of the Baltoro glacier.

The second point I would refer to, is the question of the Cornice glacier. Dr. and Mrs. Workman have proved clearly, by their photographs, that the place where I put the exit of the Cornice glacier is barred across by a rock wall. When I was on the spot, that rock wall was hidden under clouds. By some peculiar divination, for which I give myself great credit, I must have discovered that there was a glacier behind that wall, for my only reason for marking the glacier on the spot where I did, and where the Cornice glacier is actually situated, was because on that foggy day I thought I saw it. Now it appears I did not, and therefore, frankly, I know nothing at all about the Cornice glacier. I wish, however, to call attention to the very remarkable fact, which Dr. and Mrs. Workman have put on record. They have looked down into the Cornice glacier basin from various points. This glacier basin lies at a level approximately 17,000 or 16,500 feet above sea-level, and the wall on the side where they showed us the photographs cannot be above 1000 feet above glacier-level. So that you have a glacial basin entirely surrounded by mountains, at one place only 1000 feet high, and this glacier basin has no exit whatsoever. There it is, and there it has been, I suppose, for thousands of years; and into that basin there must have been pouring snow all that time, and yet it is not full up: 1000 feet of snow would fill it, and to make a thickness of 1000 feet of snow would certainly not take above two hundred years of snowfall, and it has had a great deal longer than that. Now if there is no exit anywhere, how does the snow get away? Why has it not filled up and overflowed the low gap that opens to the Biafo glacier? My conclusion is that there must be an exit somewhere; and I think that after Dr. and Mrs. Workman's repeated journeys of exploration, they have got to go back again once more. They have got to climb into this glacier and find its outlet.

Finally, I would refer to Dr. Workman's most interesting remarks and observations

about the surface forms of snow and ice, which he has grouped under a number of different heads. I would only quarrel with him about the name under which he unites them, that of *nieves penitentes*. In my opinion all the variety of forms he has identified and grouped under different headings include no *nieves penitentes* amongst them. It is, perhaps, a mere question of name. You can call them all *nieves penitentes* if you like; only that is not what *nieves penitentes* really are. *Nieves penitentes* is a name given in the southern part of the Andes to a particular snow formation, not just the snow pinnacles, but to a particular kind of snow pinnacle. It is a snow pinnacle of a quite definite kind. It is different in appearance from anything that was shown in those beautiful slides of Dr. Workman's. They all show you phenomena connected with the surface forms of snow—how it may be moulded into pinnacle shapes and ridges of several kinds, and produced by different processes; but the *nieves penitentes* of South America are different from all of them. We have seen actual *nieves penitentes* on that screen on many occasions. The characteristic of the *nieves penitentes* is that they are moulded out of a bed of snow by the peculiar action of the sun. They are all of them roughly pyramidal in form, of an oval-pyramid form, the major axis of the oval running approximately east and west, and all the pyramids dip towards the north in the southern hemisphere—towards the sun. Then those of one group are almost always of approximately the same height, and they look (and that is why they are so called) like a crowd of *penitentes* clad in white sheets on the hill-side, and the Spaniards in South America call them *nieves penitentes*. As the season advances, the hollows enlarge and deepen between them. The sun looks down into the hollows; the reflection concentrates heat at the bottom, and the hollows are melted deeper and deeper right down to the ground. The pinnacles of snow are finally left standing on the ground, each one separate from the other, very often in hundreds. Those are what in South America they call *nieves penitentes*. You may take the name, and by analogy apply it to various pinnacular forms of snow, only you would not be understood in South America if you did. I have never seen, either actually or in photographs, anything like them in the Himalayas, or the Alps, or in Spitsbergen, or in any other part of the world, and I should be very glad to know that, after Dr. and Mrs. Workman next year have made an expedition to Cornice glacier, they will make another expedition to the Andes of Chile and the Argentine, where they will find these *nieves penitentes*, and where Dr. Workman might continue to enlarge his observations on the various forms of sculptured snow surfaces, which he has already so carefully studied. I am not now criticizing his classification; I am merely suggesting that it would be better to keep the term *nieves penitentes* for the particular form for which the name was invented. I should like once more to thank Dr. and Mrs. Workman for their delightful paper, to congratulate them on the continued success of their great achievements, and to express the hope that we have not heard them here for the last time.

The PRESIDENT (after the paper): Any one travelling in such a region as this must often be tempted merely to focus their interest on feats of mountaineering. I believe I am right in saying that the feats accomplished by Mrs. Bullock Workman are more remarkable in the way of mountaineering than those which have been performed ever before by any one of her sex. Whether I ought to make that limitation or not, I am rather doubtful, but at all events, with that limitation, it will not be denied. But in spite of all the difficulties, our travellers have throughout the whole of their journeys kept their eyes steadily fixed on geographical work, and have therefore brought back with them ample stores of new information, both with regard to the topography of the districts visited, and concerning those interesting snow columns, whether they be called *nieves penitentes* or not. Therefore, I am sure

in the name of every one here present, we not only thank them for their extremely interesting papers, but wish them good luck the next time they go to these regions —good luck in conquering new peaks and traversing new icy fastnesses.

Dr. WORKMAN: I am greatly surprised at the assertion of Sir Martin Conway, that the formations I have shown on the screen to-night are not *nieves penitentes* at all. If they are not *nieves penitentes*, I would ask him, What are they? His conception of *nieves penitentes*, as he gives it, is too restricted to be up to date. In the light of the careful observations made during the last fifteen years in the Andes, in the Sierra of North America, in equatorial Africa, in Himalaya, and even in Iceland, it cannot be said to-day that this formation occurs only in the Andes, or only on one variety of basis, or that the pinnacles have any exclusive shape or size, or that their long axis or the lines in which they may stand orient only east and west.

Among others who have studied them elsewhere than in the Andes, Prof. Hans Meyer, than whom there is no higher authority on *nieves penitentes*, who has seen them in great quantity in various localities in the Andes, and who, therefore, according to Sir Martin Conway's standard, if any one, should be able to recognize them, asserts that he found typical *nieves penitentes* on Mount Kilimanjaro and in the crater of Kibo in Central Africa.

Sir Martin's argument to support his contention that an enclosed glacier cannot exist because the basin in which it lies would fill up with snow is not convincing. It is true that Nature furnishes a new supply of snow to feed a glacier each winter, but it is also true that, during the succeeding summer, it removes a large amount of such snow by melting and evaporation, even above the snow-line, and below it the waste exceeds the supply, till the glacier finally dies out.

There is no reason why an enclosed glacier should not die out within its own basin without having an outlet on another glacier, provided its basin falls to an altitude sufficiently below the snow-line. The question of the life of a glacier is simply one of supply as compared with waste, irrespective of its connection with any other glacier or of its basin with any other basin.

Cornice glacier in question, from its origin on the west Biafo wall, occupies the bottom of a deep narrow valley, or nala, with precipitous sides. Its reservoir is therefore small, and the amount of snow which collects to feed it limited. From its head it descends speedily to a level of 15,000 feet, and then considerably lower than that, *i.e.* to a level much below the snow-line of the region. Further, the valley and glacier run from east to west, and the sun pours its rays into the former upon the latter for many hours during the long summer days with a heat of from 180° to 210° Fahr., the melting effect of which is increased by the confining of the heat by the perpendicular enclosing walls, which exclude all wind. The singeing heat experienced in such valleys is well known to those who have travelled through them in Himalaya during the warm hours of the day. Under these circumstances the wastage from melting and evaporation equals at least the increment from the winter snow-supply, and in fine-weather seasons must exceed it, and is sufficient to keep the glacier, as we saw it, at the very bottom of its nala.

When we looked down from the col at the head of the Hoh Lumba (overhanging Cornice glacier not a great distance below its origin) upon Cornice glacier beneath us in the middle of June, its surface even at that point and at that early season consisted of fully formed glacier-ice, cut up by crevasses, entirely denuded of winter snow and *nieve*, which had already melted away. This was six to eight weeks before the maximum of melting takes place in that region, and, with the sun exerting its destructive effect upon that narrow surface of ice for another eight weeks, it is easy to judge what the chances are of that glacier filling up the chasm 2000 to 3000 feet deep, at the bottom of which it lies.

The noteworthy facts, that this glacier lies at a much lower level than the corresponding portions of other glaciers around it, that it is composed of fully formed ice, while they are deeply covered with snow and *névé*, and that it is enclosed on all sides by high mountain walls, in which the direct observation of those who have been entirely around it has disclosed no opening, as well as the indications afforded by the condition and size of the glacier itself, supply more conclusive evidence that it is enclosed only by and ends only in its own basin, than the disbelief of Sir Martin Conway, who has never seen the glacier nor any of its barriers, except the south Hispar wall, which, according to his own testimony, has no opening at this part.

A NATURALIST'S TRAVELS ON THE CONGO-ZAMBEZI WATERSHED.*

By S. A. NEAVE, M.A., B.Sc. Oxon.

THE following notes are the result of more than four years' wanderings in Northern Rhodesia and the Katanga region of the Congo Free State. Some of the country here discussed has already been dealt with by Mr. L. A. Wallace, the present administrator of North-West Rhodesia, in the *Journal* of this Society for 1907, pp. 369 *sqq*. He has there described the main geographical and geological features of the country very fully. It may, however, be of some interest to supplement his excellent account with some notes on the faunistic features of this part of Africa—more especially as I was fortunate enough to travel some considerable distance through a contiguous area in the Congo Free State, a region which does not come within the scope of Mr. Wallace's paper.

Before dealing with the local conditions, it is necessary to shortly review the general distribution of the fauna of Africa south of the equator. The South African subregion has usually been considered to be bounded to the north by the Zambezi river, on the east, and by the Cunene river on the west, and this is, no doubt, roughly correct. It is, however, of great interest to observe that whilst the tropical species of the equatorial zone (I am here more particularly referring to butterflies and other insects) have spread down the east coast as far as Durban, they do not on the west extend much below the Kwanza river in Angola, a difference of 20° of latitude. This is no doubt mainly due to the high central plateaus on the eastern side of the African continent in this latitude being remote from the sea-coast, whilst on the west, in Angola, the lowlying coast-belt is vastly narrower. On the west side the advance of a tropical fauna to the south is also much checked by the very dry climate which obtains on the coast-belt in southern Angola and to the south of it. This great central plateau is often hundreds of miles wide, and in this latitude its long

* Read at the Royal Geographical Society, November 22, 1909. Map, p. 224.

axis runs roughly east and west, so that it would be possible to travel from German East Africa to within 200 miles of the coast in Angola without descending below 4000 feet above sea-level. The Congo-Zambezi watershed forms the backbone of the central portion of this plateau.

To demonstrate that the high land which forms this watershed is an important barrier to the advance of the western tropical fauna is the chief object of this paper.

Before entering into the details of the area under discussion it will, I think, be convenient to subdivide it into three very natural divisions. These are—

(1) The low ground in the Zambezi basin.

(2) The Congo-Zambezi watershed and the high ground on either side of it.

(3) The low ground in the Congo basin.

The first of these divisions, so far as Northern Rhodesia is concerned, is limited to the valley of the Luangwa river and to a small portion of the mid-Zambezi valley. The vast proportion of this area lies below 2500 feet, and only comprises higher ground towards the borders of Nyasaland and Portuguese South-East Africa. The fauna and flora of this lowlying area are quite distinctive compared with that of the rest of Northern Rhodesia. The mammals, birds, and insects found in the Luangwa valley are mainly those which occur in the lower Zambezi valley and much of the south-east coast region of Africa.

There are also present a few species which, though not known to occur south of the Zambezi, have already been recorded from Nyasaland. As an example of these latter may be instanced the pretty little love-bird, *Agapornis lilianæ*, Scl.

A very large proportion of the Luangwa valley consists of broad alluvial flats through which the river flows. The bed of the river is very wide, the sandy banks often having an edging of phragmitis reed, the white plumes of which are very effective at a distance. A close acquaintance, however, with this plant is not desirable on account of its spear-like blades.

The Luangwa valley exhibits a very different appearance at the different seasons of the year. At the height of the rainy season the river is a wide and turbulent waste of muddy waters, and often overflows its banks. At this time the flat stretches of alluvial soil in the neighbourhood of the river are singularly unpleasant to travel over. On these flats the soil largely consists of a peculiarly tenacious and impermeable clay of a dark grey colour. The huge cracks which form in this clay during the dry season are rapidly filled up by the first heavy rains. When this has once taken place the whole country soon becomes water-logged, and, when once in this condition, even a slight shower will produce standing water everywhere. When making a journey up the Luangwa river in February and March, 1908, I was

much astonished at the extent of the floods. It was an extraordinary sight to see huge stretches of "mopane" forest standing in from 6 inches up to 3 or 4 feet of water. This tree, a species of Copaifera, the "ironwood" tree of Livingstone, is a remarkable one and highly characteristic of this area; in fact, so far as North-Eastern Rhodesia is concerned, it is confined to the basin of the Luangwa river. More particularly in the low ground of the valley large stretches of forest composed almost entirely of this tree are met with. This is an unusual character in the African woodland or forest, which is much more generally composed of a great variety of trees. It is perhaps here well to point out that dense forest formed of large trees as opposed to woodland is distinctly uncommon in any of the areas under discussion, though, as we shall see later, it occurs occasionally in the Congo basin. A very large proportion of the whole country, more especially the hilly areas, is more or less uniformly covered by rather thin woodland, the majority of the trees being of moderate size.

In the "Mopane" forest but little grows beneath the trees and in the clearings among them except short and not very vigorous grasses. This, perhaps, is due to the peculiar conditions of the soil. To grow successfully in a heavy clay which is water-logged in summer and baked as hard as a rock in winter, no doubt requires considerable specialization. The "mopane" trees seem peculiarly adapted to these conditions, but do not as a rule grow to a very large size, nor with very straight trunks. This rather discounts the commercial value of their timber, which is, however, very hard, and said not to be attacked by termites. The living tree is strangely inflammable. The natives take advantage of this peculiar character. In order to fell one of these trees, they insert a burning stick into a crevice in the trunk. The tree will then begin to smoulder, and will fall burnt through the trunk within some twenty-four hours, and then, if left to itself, will lie smouldering on the ground for days. Another tree which is common in the Luangwa valley, and characteristic of the eastern tropical region, is the grotesque baobab. Yet another type of vegetation, often in patches of considerable size, occurs commonly. This is locally called by the natives "lusaka" or "malusaka," and consists of rather dense thickets of shrubs mixed with creepers and occasional trees and thorn scrub. This country is extremely difficult to travel through, and when very extensive even natives are easily lost in it.

In the height of the dry season the Luangwa valley has an appearance vastly different from that in the wet. When the bush-fires, which generally occur about July, have destroyed the grass and smaller undergrowth, the trees, except for a few species of ficus and other evergreens on the river and stream banks, all lose their leaf, giving a very barren appearance to the country. At this time the Luangwa river itself, especially on the upper part of its course, becomes little

LUANGWA VALLEY.

NATIVE CHIEFS AND THEIR WIVES BRINGING FLOUR.

LOFU RIVER.

DIKULWE RIVER.

more than a shallow and winding stream, dotted and margined with sandbanks.

It is now that the river becomes a feast for the eye of the naturalist and sportsman, presenting as it does a most wonderfully varied scene of animal life. The sandbanks are covered with storks, cranes, plovers, and wading birds of all sorts, the comparatively cryptic colours of many of them being varied with the snowy plumage of the egrets, which, in company with many others of the heron tribe, frequent the marshy parts of the banks.

Now and then a small flock of the African skimmer (*Rhynchops*), with their swift but zigzag flight, pass up or down the stream. With luck one may see in the distance four or five of the beautiful crested cranes (*Balearica*) performing their quaintly solemn dancing, or the handsome but wary saddle-billed stork (*Ephippiorhynchus senegalensis*) may be observed in pairs, stalking along the water's edge or on the grassy flats. This river seems specially suitable to the crocodile, large numbers of which may be seen basking on the sandbanks during the heat of the day.

Regularly morning and evening, as well as at night, large herds of game come down at this season to drink. At this season, too, the resident inhabitants of the river-banks, such as water-buck, puku, bush-buck, impala, zebra, etc., have been reinforced by other species which spend their wet season on higher grounds. Amongst these are Lichtenstein's hartebeeste, kudu, roan antelope, and rhinoceros.

When the rains break, which they usually do very suddenly, the whole country changes as if touched with the wand of a magician. In two or three days everything bursts into leaf, and the ground becomes covered with a carpet of dazzling green velvet, contrasting with the grey-green foliage of the "mopane" trees. These "mopane" flats, as they are often called, have a very characteristic fauna. The South African giraffe, occurring nowhere else in this part of Africa, still exists in small numbers in the central part of the valley. The beautiful and graceful impala antelope, which is very rare on the plateau to the west, occurs in considerable numbers. The blue wildebeeste, which does not occur elsewhere in North-east Rhodesia, is found thinly, though widely distributed over the upper part of the valley. In common with the water-buck this antelope does not follow the example of the other large species, such as the roan antelope, in making for the foothills in the rainy season, but continues to inhabit the more or less flooded country. It should here be noticed that the common water-buck (*Cobus ellipsiprymnus*), which is so abundant in this low country, does not occur on the high plateaus to the west. Of the smaller mammals the most characteristic is perhaps the little squirrel (*Funisciurus cepapi*), which is extremely abundant here, though uncommon elsewhere on higher ground.

Amongst the characteristic birds, especially of the mopane flats, may be mentioned the red-billed hornbill (*Lophoceros erythrorhynchus*), which the natives call "kopi kopi" in imitation of its cry. Another peculiar bird is the stripe-chested weaver (*Ploceipasser pectoralis*), which I did not meet with in any other part of the country. This bird builds extremely untidy nests of dried grasses, placing them, as a rule, at the extreme end of the boughs of a thorny species of mimosa. It is a very noisy bird even for a weaver, especially during the nesting season. Another bird, which is here, apparently, at the extreme northern limit of its range, is the South African sandgrouse (*Pterocles bicinctus*). This bird, which is generally found near water, so much resembles the ground, and lies so close, that in spite of the absence of cover, one often all but treads on it before it rises. Another game-bird, which is here on about the western limit of its range, is the common East African guinea-fowl (*Numida mitrata*). As we shall see later, this bird is replaced on the high plateau by another species.

Innumerable other instances might be given of animals which occur commonly in the Luangwa valley, but which are either non-existent or very rare on the high plateau. It will here suffice to say that the animals of all classes in the Luangwa valley are either identical with, or very closely allied to, those of the eastern and south-eastern coast regions within the tropic.

We now come to the second subdivision of our area, namely, the high plateau country, the backbone of which forms the watershed between the basins of the Congo and Zambezi rivers. In the north-east corner of Northern Rhodesia the watershed lies very near to the edge of the plateau. This edge is formed by the great Mchinga escarpment which is the western boundary of the Luangwa valley. About lat. 13° S. the watershed turns nearly due west, and becomes the boundary between North-Western Rhodesia and the Congo Free State. South of this point the escarpment is broken up by the lowlying valley of the Lukashashi river, which resembles that of the Luangwa in character and fauna. Ultimately this wall-like escarpment, turning westward, gradually falls away toward the upper Zambezi valley. The whole of North-Eastern Rhodesia, therefore, west of the Mchinga escarpment is included in this high plateau area, with the exception of the low ground in the valleys of the Luapula, Kalungwisi, and Lofu rivers, and the shores of Lakes Mweru and Tanganyika. These we shall deal with presently.

This area also includes a wide strip along the watershed, forming the boundary between the northern portion of the North-Western Rhodesia and the southern portion of the Congo Free State.

This high plateau country has a great general similarity throughout as regards its flora and fauna. For the most part flat, it is extensively covered with woodland, but the open grassy plains are much larger and

more numerous than on the lower ground just discussed. The protection of this woodland from the natives is a problem which is not yet successfully solved by the administration. Almost throughout this area the natives avoid, for purpose of cultivation, the lowlying grass-covered areas on the banks of streams and vleys, the small amount of drainage necessary, being apparently the factor which deters them. They are, therefore, confined to cultivating their crops in the higher and dryer, though less fertile ground in the woodland.

To do this they cut down the timber over a large area, and collect the cut branches, etc., into a few circular patches, having chosen, if possible, for this purpose the neighbourhood of a large termite mound. They set fire to these, and the resulting ash forms the manure for one or at most two years' crop. The consequence of this is that, though but little ground is actually cultivated, enormous areas of timber are destroyed. In fact, in the more populous parts it is difficult to find woodland which has not suffered in this manner at some time or other. It is true that in the northern part of the country amongst the Awemba and neighbouring tribes, the trees are seldom killed outright. In this part it is the custom among the natives to climb up the trees and lop all the branches off. Further south, among the southern Babisa, Ba-lala, Ba-lamba, and some of the Congo tribes, the trees are usually cut down some 3 or 4 feet from the ground. Yet another evil arises from this method of cultivation, because the bush is not fired by the natives until very late in the year. This is due to the inherent laziness of the native who defers the preparation of his garden till the last moment. The result of this is that the native who has his garden ready has to wait to fire the bush until the laggards also have their gardens in the same state. This late burning of the bush is a very serious evil. Among the Awemba and other tribes to the north it frequently does not take place until the trees have assumed the foliage of the following year. It should be pointed out that in the comparatively cool and temperate climate of the high plateau, the onset of spring commences much earlier, and is a much more gradual phenomenon than in the lower ground, beginning as it does long before the onset of the rains. It is at this season that the most wonderful tints are seen in the woodland. Much of the young foliage at this time exhibits many varied and beautiful shades of red and pink.

The problem of this forest destruction becomes annually more and more serious, but is not at all an easy one to solve. Like all primitive races, the Central African native is an extremely conservative individual. His present method of cultivation entails a considerable amount of labour, and his crops, which consist chiefly of a dwarf species of millet, are far more scanty and at least as uncertain as those of sorghum and maize grown by the tribes inhabiting the lower ground. It has, further, already been shown that, where tried, maize, etc., has been grown quite

successfully in this upland country. In spite of all this, the native of the high plateau does not take at all kindly to any form of cultivation other than that carried on by his forefathers. This is especially so amongst the Awemba, the most dominant and intelligent of the plateau races in North-Eastern Rhodesia. This opposition seems to be largely fostered by the women, who have considerable influence amongst this tribe. This hostility on the part of the women to a change in the method of agriculture is not unnatural. It is due to the fact that the method of cultivation by cutting the timber is very largely a man's work, whereas the reverse is the case in cultivation with the hoe. It has been necessary to refer at some length to this question of timber cutting, since it has a very marked influence upon the general appearance of very wide areas. Once they have been cut, the tree-stumps or pollarded trunks have to undergo a very keen struggle to survive the annual bush fires. In consequence of all this, a good deal of country is covered with ragged scrub instead of woodland, formed of moderate-sized trees.

Where this high plateau country is undulating, the valleys of even the smallest streams are sharply outlined by being bordered with sloping grassy plains of varying width. When a certain elevation from the stream is reached, the grass land is margined by a very definite line of timber. These long narrow plains follow the courses of the streams for great distances, and they vary from 50 yards to a mile wide, according to the degree of slope. They are usually covered with wiry and not very long grass, the surface being very tufted and uneven. In cases where the slope is a fairly steep one, the edges of these grassy valleys are often covered with large quantities of bracken—an old friend, which seems somewhat out of place in Central Africa. This type of country is a particularly favourite one for the noble sable antelope. It is a very fine sight to see a coal-black bull, morning and evening, marshalling a herd of his bright bay-coloured wives on these small plains.

Another characteristic feature is the "msitu," to use a local term. These are patches of dense forest seldom more than a few acres in extent, sometimes much less. They are commonly on the source or banks of a stream. Formed of immensely tall trees, much crowded together and with a tangle of creepers around their trunks, they often stand out in patches of open marshy ground in the most strange way. In the Congo basin, especially towards the west, near the Angolan frontier, these "msitu" become much more extensive, and continuously follow the course of small streams for many miles. These patches of tropical forest frequently contain trees of great girth, much valued by the natives for canoes. The fauna of these somewhat isolated patches is peculiar compared to that of the surrounding country. They are not much frequented by the larger mammals, being chiefly the haunt of leopards, monkeys, and the little bluebuck (*Cephalophus nyasæ*).

The birds and insects are, however, highly characteristic. Among the birds the ground thrushes (*Cossypha, spp.*), and various woodland species of Bulbul are well represented. An interesting bird which is an annual visitor to these forest patches, is a gorgeous glossy starling (*Lamprocolius glaucovirens*). This West African bird visits these spots on the high plateau from September to November, possibly longer. It apparently does so to breed, as I have found young birds which could just fly, the first week in November. They also seem to select the time when the fruit is ripe for their visit. These birds have the most bewilderingly ventriloquial voices, and an extraordinary range of notes.

Among the more remarkable insect inhabitants of these spots are the formidable driver ants (Dorylus). These wonderful insects occur everywhere, but are particularly common in the high plateau country and in the neighbourhood of water. They are frequently to be seen marching in vast armies, several individuals abreast. Many of these are carrying food supplies, and are guarded on the flanks by innumerable armed sentries. Woe betide the man who is so unlucky as to tread amongst them. He is immediately covered with a host of bloodthirsty enemies, who bury their mandibles in his flesh, producing the sensation of innumerable red-hot needles. The insects not infrequently invade camps and native villages, and can then only be turned from their objective by a line of red-hot ashes. Except for the inconvenience of being turned out of their huts, these visits are not objected to by the natives. Every living thing has to depart hurriedly or die on these occasions, with the result that much of the vermin disappears—for a time, at least. Another insect, nearly as warlike as the driver ant, is a species of Ponera, a large black ant which has a powerful and painful sting. This insect is particularly addicted to walking on native paths, and usually does so, about four or five abreast, flanked by a few skirmishers. When alarmed, the whole community has the singular power of being able to produce a peculiar rustling noise. It wages perpetual war upon the termites, and may often be seen returning from a successful foray. On these occasions the majority of the army is laden with the bodies of their victims.

It is impossible, in describing any part of tropical Africa, to avoid some mention of the termites. The different species of these insects build very varied and remarkable mounds. Some of them are of enormous size, and have a marked influence upon the landscape. They are sometimes as much as 20 feet high, and are frequently placed at somewhat regular intervals about 30 or 40 yards apart. On the plains, on the other hand, the commonest species makes a much smaller mound, and it is a striking sight to see a grassy plain apparently studded with innumerable grey objects looking very much like stalagmites. In some parts of the plateau in the Congo basin country there

is a species which makes a small mushroom-shaped mound, a new top being apparently added each wet season. The result of this is that an old nest looks like a pile of hats or flat, somewhat circular pudding-dishes.

One of the most remarkable spots in this high plateau country is a large pool in the limestone in the valley of the upper Kafue river, North-Western Rhodesia, and not far from the old administration post of Kapopo. I have already given some account of this spot in a short abstract of my first journey,* but perhaps, having paid it a second visit, it will not be out of place to give a further account of it.

This wonderful pool lies in flat country, and one comes on it quite suddenly, its banks being concealed by some dense forest. Indeed, without foreknowledge of the existence of this pool, the traveller might pass within 50 yards of it and not realize its presence.

The pool is roughly square and somewhat over 100 yards across. The walls are of limestone and so precipitous that it is only possible to get down to the waters at one spot. On both occasions when I visited this pool, in October, 1905, and January, 1907, *i.e.* just before and just after the beginning of the rains, I found the water-level to be approximately the same. This was some 16 feet below the top of the walls, which closely represents the level of the surrounding country. Judging, however, from the flood-marks on the walls, there would appear to be a considerable rise in this water-level during the height of the rains. This would seem to point to some underground connection with the local water system. The water itself is extremely still, clear, and intensely cold. There were little or no signs of vegetable life, but a number of fish were visible, some of them of fair size. So pellucid was the water that it was easy to see them quite clearly at a considerable depth. I made an attempt to sound this pool, and though I used 300 feet of rope I could not find bottom. This was the case even when it was done only at sufficient distance from the side to ensure the large stone, with which the line was weighted, not lodging on any ledge on the walls.

There is a small native village near this pool, and the inhabitants have a superstitious dread of it. The local native refuses to drink the water or use it for any purpose whatever. This attitude on the part of the natives is perhaps not entirely unreasonable. To sit beside this still pellucid pool of unknown depth, surrounded by precipitous walls, situated as it is in the heart of the tropical forest, would, I think, induce a feeling of awe in the breast of even the most civilized man.

Another striking feature of the high plateau areas are the huge stretches of shallow water or pans which occur upon it. Of these the most important is, of course, Lake Bangweulu. Moir's lake, near Serenje, and Lake Young, near the source of the Mansya river, a

* *Proc. Manchester Literary and Philosophical Society*, vol. 51, pt. 2, 1906-07.

KATWELUME FALLS, KALUNGWISI RIVER.

POOL NEAR KAPOPO.

THE "MSITU."

COPPER MINE NEAR KAMBOVE.

tributary of the Chambezi, are small editions of it. As regards Lake Bangweulu, comparatively little of it is represented by permanent open water, and its shores, particularly to the east, are very ill defined. So flat is the country in this direction that many of the rivers are little more than swamps.

The shores and swamps of Lake Bangweulu, more especially during the dry season, exhibit a most amazing spectacle of bird-life. Besides eight or nine species of duck and geese, I obtained or noted on this lake innumerable herons, egrets, coots, ibises, kingfishers, etc. There were also present a small species of gull and huge flocks of the strange "open bill" (*Anastomus lamelligerus*), and many other birds. Amongst the water-plants were quantities of the wonderful and graceful jaçana, or "lily trotter" (*Actophilus africanus*).

On the more or less flooded plains, which at the time of my visit in July were fast drying up, were many plovers, small wading birds, and quantities of the African painted snipe (*Rostratulus capensis*). Everywhere, in fact, birds too numerous to mention met the eye. In the papyrus swamp there were numbers of the larvæ of a large moth, perhaps a Saturniid. These, which are mentioned by Livingstone, are said to be still more numerous at other times of the year. On the shores, more particularly of the islands, I found patches of jungle, somewhat different in character from the "msitu" above described. They are much more largely composed of dense and tangled thickets, the larger trees being comparatively few and far between. These thickets are locally called "mateshi," and on the shores of the mainland, especially near the river mouths, are the favourite resort of elephants.

In this country east of Lake Bangweulu, the ground, especially near the sources of rivers and streams, exhibits that peculiar kind of marsh so well described as "sponges" by Livingstone in his 'Last Journals.' These sponges are generally covered with a cushion of short wiry grass and matted marsh-loving plants. They remain more or less water-logged throughout the whole year, including the dry season.

The highly mineralized area of Katanga, on the Congo side of the watershed, belongs also to this "high plateau region," but presents some special features. It is, for the most part, somewhat mountainous and broken country.

The copper belt is clearly delineated by the bare hills which are to be seen everywhere within it. This peculiarity, which is due to the copper ore in the ground preventing the growth of trees, is very unusual in this part of Africa. Everywhere else, except when absolutely precipitous, the hills and mountains are covered by woodland, thus giving a characteristically "woolly" appearance to the landscape. To the north of the copper area we begin to get into lower ground, but the high ground still remains as huge island plateaus. These have usually well-defined and sometimes precipitous edges. As examples of them may be

cited the "Biano" plateau, between the Lualaba and Lufira rivers, and the still larger Kundelungu plateau, between the latter river and the Luapula. These isolated areas of elevated land are seldom inhabited by natives. Their top is usually flat or nearly so, and is covered with somewhat wide open plains interspersed with woodland. The fauna of these spots does not differ materially from that found at similar elevations to the west in Angola, or to the east in Rhodesia. In the high ground, west of the copper belt, not far from the watershed, especially near the upper Lufupa river, there are present certain peculiar features in the landscape. These are numerous plains or undulating areas of curious moorlike ground, covered only with stunted grasses and plants. Somewhat similar country may be found to the south-east of Lake Bangweulu. Here there are a number of rather similar open plains, which are remarkable for being the only spot where the "tsessebe" antelope exists in this part of Africa.

Having now described some of the more striking features of this elevated region, we may now discuss its fauna in general. On the whole, it closely resembles that which occurs throughout a wide area in Central Africa at the same elevation, in the form of varying-sized islands, lying among the more typically tropical fauna of the lower ground. Thus our area has close faunistic affinities with the interior of Southern Angola on the one hand, and the plateaus to the north on the other, including those both east and west of Lake Tanganyika, even up to the Victoria Nyanza. Though true in the main of the whole animal kingdom, this applies more especially to insects. In the case of birds, which, as might be expected, range more widely, we already find a certain proportion of western tropical forms. In comparing the larger mammals of this high country with those of the Luangwa valley, we find that many of the characteristically southern and eastern species are absent. As already pointed out, the giraffe and blue wildebeeste disappear, and impala, bushbuck, and kudu become extremely local. The puku, on the other hand, is very abundant, and seems to belong to a somewhat larger race. Among the animals not represented in the Luangwa valley may be mentioned the "situtunga" (*Tragelaphus selousi*) and the black lechwe (*Cobus lichi smithemani*, Rothsch.).

Crawshay's sing sing water-buck (*Cobus defassa Crawshayi*) has also replaced the common water-buck of the Luangwa valley.

Among the birds of this area, which are of interest from the point of view of geographical distribution, is a yellow-helmeted Guinea-fowl (*Numida marungensis*), originally discovered near the west shore of Lake Tanganyika. Once the Mchinga escarpment is ascended, this seems to be the only Guinea-fowl over a wide area, those of the Luangwa valley, the common species (*N. Mitrata*), and the beautiful crested Guinea-fowl (*Guttera edouardi*) disappear altogether.

Innumerable other instances throughout the animal kingdom might be given of the differences between the high plateau fauna and that of the Luangwa valley. One of the most instructive things a student of geographical distribution can do is to climb the 3000 feet or thereabouts of the Mchinga escarpment, out of the low-lying Luangwa valley, and find himself in a new world of animals and plants.

I cannot leave the high ground without making some reference to the flowers, which are much more in evidence than at lower elevations. Among the more striking are many species of Gladioli inhabiting the most diverse situations, some growing among the swamps, others among the rocks on the hillsides. In spring the grassy, somewhat swampy ground is gay with Tritomas, Crinums, and Convolvuli. Autumn is another time which is characterized by abundance of flowers, more especially in the woodland. At this time the woods are gay chiefly with Compositæ. Some very handsome cornflowers also especially call for notice, particularly a large blood-red one.

This, then, is a brief and necessarily inadequate description of the high plateau of this part of Central Africa. It is a land with a moderate and equable climate, where the sun is seldom if ever really troublesome. Of great natural beauty, and swarming with game, it is a paradise for the traveller, only marred by the native methods of agriculture and the consequent difficulties of food supplies. It is eminently suited for, and doubtless will one day become, the home of a white race.

We now come to our third and last faunistic district. This area is confined to the river-valleys and low ground within the Congo basin. In North-Eastern Rhodesia it is limited to the lower Luapula and Kalungwisi valleys, the shores of Lake Mweru, and to a less degree the shores of Lake Tanganyika and the lower Lofu valley. Within the Congo Free State this area, of course, comprises all the low ground in the river basins. The fauna of this area is closely allied to that of the tropical west coast. I did not personally visit the actual shore of Lake Tanganyika, but from a short inspection of the lower Lofu valley, it would appear that its fauna is a mixture of those animals characteristic of the western and eastern tropical regions.

The course of the above-mentioned rivers, both in British and Congo territories, all exhibit much the same history. Their upper waters pass through the more or less flat plateau country just described, the fauna of their banks not differing from that of the surrounding country. As soon, however, as they begin to descend from the high ground, these rivers, with few exceptions, pass through a series of gorges, and their banks, instead of being only slightly, or not at all, wooded, begin to be edged with more or less tropical forest. This is very well exemplified by the Lualaba river. This river, which, when on the flat plateau is nearly 100 yards wide, is suddenly compressed between two huge rocks

at the point where it enters the gorge, and becomes for a short distance a boiling torrent less than 20 feet across.

The presence of these tropically forested banks coincides with the appearance of a western tropical fauna, and also, as I am pointing out elsewhere,* with the occurrence of *Glossina palpalis*, the tsetse fly, which, as is well known, carries Sleeping Sickness.

Thus our third area, which begins as narrow strips following the course of the lower portion of the main rivers of the Congo basin, increases in extent as the low ground is reached. This low country in the Congo basin has a vague general resemblance to that already described in the basin of the Zambezi. The actual fauna and flora are, however, altogether different. In the grassy alluvial flats, palms, etc., are much more numerous, and the baobab has disappeared.

The woodland is much more dense, and here and there merges into forest. The fauna, more especially the insects and the birds, particularly the smaller Passerines, is characteristic of that of the tropical west coast, and this character becomes more and more marked the further one advances down the tributaries of the Congo. To demonstrate the faunistic differences between these forested river-banks of the Congo basin, and somewhat similar localities, we may take an instance among the butterflies. The characteristically large and gorgeous western tropical genus Euphædra is well represented in these Congo river-valleys. I took there myself some nine species, including one which also occurs throughout the high plateau. In the valley of the Zambezi, on the other hand, and indeed throughout the eastern tropical coast, this genus is only represented by a single somewhat aberrant species.

It has now been shown that this part of Southern Africa comprises two low-lying districts separated by a wide area of high ground, and that each is characterized by a distinct fauna. It has been the object of this paper to demonstrate that the Congo-Zambezi watershed and the high land on each side of it has caused this faunistic difference. For a considerable geological epoch this high ground must have kept separate much of the animal life, inhabiting the low ground in each of the river-basins, just as it serves to separate the waters of the two great rivers.

The PRESIDENT (before the paper): Mr. Neave, who has kindly consented to lecture here to-night, is a naturalist who has spent about two years in South Central Africa. He has been studying the Congo-Zambezi watershed with a view to ascertaining its influence on the distribution of animals and plants in that interesting region, and it is the result of these two years' travelling he is going to describe to us to-night. I am glad to say Mr. Neave, since he has returned to England, has been appointed by the Colonial Office a member of the Entomological Research Committee which is about to proceed to British East Africa in order to

* *Journal of Economic Biology*, vol. 4, pt. 4, p. 109 *sqq.*

study insect life in those regions, more especially with a view of ascertaining whether there is any way of preventing the diseases which these insects give rise to in human beings.

Dr. P. L. Sclater: I am afraid I can offer but a very few remarks on the excellent paper we have just heard read. My personal experience has been confined entirely to the Cape Colony and the extreme southern portion of Africa, but I look forward with very great interest, as a naturalist, to the exploration of these northern provinces that has been lately commenced. There is no doubt that when Mr. Neave's large collections come to be worked out, as they will be, with the help of his friends at the British Museum, we shall advance very much in our knowledge of the fauna of South Africa. In the works that my son, Mr. William Sclater, formerly of Cape Town, has published on the mammals and birds of South Africa, I am pleased to see that he has anticipated, I might almost say, the very divisions, between the northern and southern faunas to which Mr. Neave has alluded in his paper. Mr. Neave has made wonderful discoveries in a very short period. He has carried out two successful expeditions through these northern parts of South Africa, and I am pleased to hear that he is now about to return to Africa to take up exploration in another quarter. I am sure we shall all join in wishing him success.

Mr. William Sclater: I have very little to add to what my father has said. My studies have been almost entirely confined to Africa south of the Zambezi. In the works which my father so kindly alluded to, that river was the boundary which I took for the fauna of South Africa, and I had very little to do with fauna north of the Zambezi, although I was always naturally very interested in it. Before Mr. Neave went out on the geodetic survey, Dr. Storr, who was the medical officer of the geodetic survey with which Mr. Neave was afterwards connected, collected a large number of birds, which I had the pleasure of working out at the Cape. Among them there were a number of very interesting species, which seemed to point to the same results that Mr. Neave has told us about, namely, that the high plateau between the Zambezi valley on the one side, and the Congo on the other, formed the boundary of the South African fauna. I have naturally listened to Mr. Neave's paper with great interest, and I think you will all join with me in wishing him success in his future investigations in East Africa.

Mr. Ogilvie-Grant: I am afraid I was not aware that I should be called on to make any remarks this evening, so I am hardly prepared to do so, and I do not think I can add very much to what has already been said. There is one thing, however, I should like to say: Mr. Neave has not told us much about his collections, and as a rule we are accustomed to have large collections sent home with very insufficient field-notes. Now, Mr. Neave has excelled greatly in this point, and I think I may say he is certainly one of our very best field-observers. On butterflies, especially, we are accustomed to read papers which are extremely dry and uninteresting, but Mr. Neave has just forwarded to the Zoological Society of London a very fine report on his collection of butterflies, which is teeming with interesting field-notes on their life-history, and I think in this particular respect he is almost unique. His notes on his other zoological collections are of equal value and interest.

Mr. H. Wilson Fox: It is very difficult for any one who cannot claim technical qualifications to add anything to what Mr. Neave has given us this evening, but speaking rather more from a commercial point of view than is perhaps usual in this hall, I feel this, that any one who is interested in the future development of these territories, and realizes the value of fresh information, is extremely indebted to a worker of the character of Mr. Neave. The generalizations which we have listened to to-night have, I think, taught many of us who thought we knew

something of this region, a great deal of our own ignorance. I must confess, as one who has been in a portion of that region, that I have learned much that has been new to me, and I have been specially interested in the allusion which Mr. Neave made to-night to the character of the native inhabitants of those regions. It is one of the most difficult problems that people in a new country have to deal with, how to make their work fit in, if I may say so, with the native habits, so as not to dislocate the order of ideas to which natives are accustomed too rapidly. We have to develop those territories in the best way possible, so as to make the best use of the material at our disposal. We have to displace the primitive methods of agriculture with something that is better, and to teach methods that will enable natives to satisfy their wants with less effort and better results than is possible at present. That great work, I hope, is being done gradually and effectively by the posts which the Administration of the British South Africa Company is establishing throughout these vast territories, of which you have got an illustration to-night in the admirable photograph which Mr. Neave has shown us of the post which was being established in the extreme north at the time of his visit.

Dr. Arthur Haydon: There is one point we have just heard a little about, and that is of the progress which is being made in the treatment of sleeping-sickness. We have seen various models of houses, and some example of the inoculation treatment. I should like to know what progress is being made in the control of the disease under the present conditions.

Mr. Neave: I think I might say very stringent regulations are being made in Northern Rhodesia to prevent the spreading of it, but I think it is more a question to be answered by the Administration of the country than by myself.

The President (after the paper): Mr. Neave has shown us how the highlands separate the country into three districts; how they prevent migration of animals from one part to another; and how they have created districts where the process of evolution has run different courses. To-night's paper is, in fact, the account of a Boundary Commission dealing with the boundaries between various animal kingdoms, and I am sure you will wish me in your name to thank Mr. Neave for the charming description he has given of his labours in this direction. All the speakers have joined in wishing good luck to Mr. Neave on his coming mission to Africa, and have expressed their sincere hope, in which we all join, that these labours will be successful.

THE CYCLE OF MOUNTAIN GLACIATION.*

By Prof. WILLIAM HERBERT HOBBS, University of Michigan.

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* Read before the Section of Geography of the British Association for the Advancement of Science at the Winnipeg meeting, August 27, 1909. When not otherwise credited, the views reproduced in this paper are from photographs taken by the author, mainly during the summers of 1908 and 1909.

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The Cirque and its Recession.

Introduction.—With the advance of knowledge concerning the sequence of conditions affecting glaciers, it has come to be generally recognized that for any given district the factor of supreme importance is temperature, a very moderate change in the average annual temperature being sufficient to profoundly transform a district, the aspect of which is temperate, and to furnish it with snow-fields and mountain glaciers. These slight variations in average annual temperature involve less important geological changes than must be invoked in order to greatly modify the annual precipitation. Thus it has been recently estimated that a fall of but 3° (Fahr.) in the average annual temperature would result in the formation of small glaciers within the area of the Scottish Highlands, while a like fall of 12° within the Laurentian Lake district of North America would suffice to bring on a period of glaciation.

With the probability that such climatic changes would be initiated slowly, the first visual evidence of the changing condition within all districts of accentuated relief would probably be a longer persistence of winter snows in the more elevated tracts; which accumulations of snow would eventually contribute a remnant to those of the succeeding winter, and so bring on a cycle of glaciation. From this beginning the cycle is an advancing one until a culmination is reached corresponding to the most rigorous of the climatic conditions. A resumption of a more genial climate would result in a reverse series of changes, terminating so soon as the winter's fall of snow is insufficient to produce permanent snow-drifts even in the higher areas. It is therefore proper to speak of the *advancing* and the *receding hemicycles of glaciation.*

Mountain versus *Continental Glaciers.*—The land-forms which result from glaciation within districts of strong relief when not entirely submerged beneath snow and ice, are totally different from those which are sculptured beneath a glacier of continental dimensions. Examination of university text-books and experience with students have alike convinced the writer that this difference has not been sufficiently

accented. In part, this may be explained by a rather general tendency to treat the subject of erosion by glaciers in mountains from studies made especially in the lower altitudes.* A quite general neglect of those special conditions of denudation which are operative in high-level areas of glaciers is, it is believed, responsible for an over-emphasis laid upon the U-shaped trunk valley and the hanging tributary valley, important as these features are.† This over-emphasis can, perhaps, be best illustrated by reference to a series of three successive idealistic sketches, executed with great skill by an eminent American geographer, and intended to develop especially the erosion forms which result from mountain glaciers.‡ The low-level sculpturing expressed by these sketches is, in the opinion of the writer, admirable, and a true rendering of nature. It is the failure to recognize any additional process of erosion operative in higher altitudes which destroys the value of the high-level sculpturing displayed.

So far as low-level mountain glaciation is concerned, the erosive processes are pretty well understood to be identical with those of continental glaciers, namely, abrasion and plucking. The larger proportion of projecting rock-masses in the case of mountain glaciers will, however, presume a greater emphasis upon lateral undercutting from the operation of both of these processes acting conjointly. It is the operation of an additional denuding process of the first importance, head-wall erosion, that differentiates all types of mountain glaciers from continental ones. This distinguishing process is responsible for the development of the *cirque* (Ger. *cirkus*), which is known by a variety of names in different glacier districts. In Scotland it has been generally referred to as the *corrie*, in Wales as the *cwm*, and in Scandinavia as the *botn* or *kjedel* (*kessel*). In the scientific literature of the subject, the Bavarian-Austrian word *kahr* has been used with increasing frequency for the same topographic feature. In view of this diversity in resultant topography, and despite their close genetic relationships, we would do well to sharply separate in our discussions continental glaciers from all other types, which latter we may include under the broad term of mountain glaciers.

The Glacial Amphitheatre in Literature.—It is safe to say that no topographic feature is more characteristic of the mountains which have

* "The visitor replied that he was a valley climber, not a mountain climber. He found sufficient pleasure at the mountain base, and such was my case also. Mountain-tops are indeed worthy objects of a climber's ambition, but if one wishes to get at the bottom facts, let him examine the valleys" (W. M. Davis, "Glacier Erosion in the Valley of the Ticino," 'Appalachia,' vol. 9, 1901, p. 137).

† On hanging valleys, see especially W. M. Davis, *Proc. Boston Soc. Nat. Hist.*, vol. 29, 1901, pp. 273–322; and G. K. Gilbert, 'Harriman Alaska Expedition,' vol. 3, "Glaciers."

‡ W. M. Davis, "The Sculpture of Mountains by Glaciers," *Scot. Geogr. Mag.*, vol. 22, 1906, figs. 1–3.

been occupied by glaciers than is the cirque. Approaching a range from a considerable distance, there is certainly no form which so quickly forces itself upon the attention. The U-shaped valley and the hanging side valley, important as these are, are here decidedly less impressive. Yet the great majority of works upon the subject, by ignoring the significance of the cirque, allow the reader to assume that the glaciers discovered the cirques ready formed to gather in the snows for their nourishment. Even the standard work of Chamberlin and Salisbury is open to this objection.*

Despite the attitude of the general texts, which so largely determine what might be called the accepted body of doctrine of a science, there are a number of papers dealing with the origin of the cirque. One of the first to recognize the cirque as a product of glacial erosion was Tyndall, whose keen mind has so illumined the page of mountain glaciation.† In opposition to his view, Bonney published in 1871 a somewhat elaborate article, in which the line of argument was: (1) that the Alpine cirques must have been produced by the same agency which shaped the valleys below them; (2) that the valleys were not moulded by glaciers; and hence, (3) the cirques must have been retained from the pre-glacial land surface.‡ The published discussion of this paper developed no opposition to the view, though Doctor, now Sir Archibald, Geikie stated that he could not see his way to account for the vertical walls surrounding the cirque. On the other hand, the Italian Professor Gastaldi recognized the work of the ice in the shaping of cirques in the Italian Alps, § as Helland did in those of Norway. The latter believed that excessive weathering in the rock above the *névé* played an important *rôle*, though abrasion by the ice upon the floor was the larger factor.‖ Later, Russell in America,¶ Wallace in England,** and de Martonne on the continent,†† further advocated the glacial origin of cirques. Penck has explained the development of cirques as the

* 'Geology,' vol. 1: "Processes and their Results," 1904, pp. 272–276, and especially fig. 250. See also 'College Geology,' by the same authors, 1909, p. 256.

† John Tyndall, "On the Conformation of the Alps," *Phil. Mag.*, Ser. 4, vol. **24**, 1862, pp. 169–173.

‡ T. G. Bonney, "On the Formation of 'Cirques,' with their Bearing upon Theories attributing the Excavation of Mountain Valleys mainly to the Action of Glaciers," *Quart. Jour. Geol. Soc.*, vol. **27**, 1871, pp. 312–324.

§ B. Gastaldi, "On the Effects of Glacier-erosion in Alpine Valleys," *ibid.*, vol. **29**, 1873, pp. 396–401.

‖ Amund. Helland, "Ueber die Vergletscherung der Färöer, sowie der Shetland und Orkney Inseln," *Zeitsch. d. Deutsch. Geol. Gesellsch.*, vol. **31**, 1878, pp. 716–755, especially pp. 731–733.

¶ I. C. Russell, "Quarternary History of Mono Valley, California," '8th Ann. Rept. U.S. Geol. Surv.,' 1889, pp. 352–355.

** A. R. Wallace, "The Ice Age and its Work," *Fortnightly Review*, vol. **60**, 1893, especially p. 757.

†† E. de Martonne, "Sur la période glaciaire dans les Karpates méridionales," *C. R. Acad. Sci. Paris*, vol. **129**, 1899, pp. 894–897; *ibid.*, vol. **132**, 1901, p. 362.

result of sub-glacial weathering—alternate thawing and freezing—beneath glaciers during the incipient stage particularly ("hanging glaciers").* This eroding process, he considered, would be greatest toward the middle of the glacier, so that the original concavity of the slope beneath it would be more and more deepened. It must be evident that this explanation does not properly account for the steepness of the cirque walls, which it will be remembered could not be accounted for by Geikie.

Attention was again directed to the process of cirque shaping by an important paper of Richter's published in 1896.† His studies having been made in Norway, where a country rounded and polished by the continental glacier had been only partly invested by mountain glaciers, the cirques from the latter formed individual "niches" in the uplands. Following Gastaldi, the form of these niches was happily likened to that of an armchair (see Fig. 1).‡ Richter observed that the steep

FIG. 1.—A GLACIAL CIRQUE EXCAVATED FROM THE PLEISTOCENE GLACIATED SURFACE OF NORWAY. THE NORTHERN KJEDEL ON GALDHÖPIG. (AFTER E. RICHTER.)

walls of the cirque were the only surfaces unglaciated, and hence he concluded that they were not to be ascribed to ice-abrasion, but to weathering. The moulding of the cirque floor he ascribed to abrasion, and, referring to the cirque walls, said—

"The material loosened by weathering is removed by the glacier or slides off over the *névé* to form either actual moraines, or, at least, *névé* moraines. These walls do not bury themselves in their own *débris*, and in consequence continually offer fresh surfaces for attack. Finally, the wearing away of the cirque floor by the glacier co-operates to keep the cirque walls on a steep angle and facilitates avalanching."

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* Albrecht Penck, 'Morphologie der Erdoberfläche,' vol. **2**, 1894, pp. 307-308, figs. 17-20.

† E. Richter, "Geomorphologische Beobachtungen aus Norwegen," *Sitzungsber. Wiener Akad., Math.-Naturw.-Kl.*, vol. **105**, 1896, Abt. I., pp. 152-164, 2 pls. and 2 figs.

‡ See topographic definition of the cirque by De Martonne ("La periode glaciaire dans les Karpates meridionales," *C.R.*, 9e Cong. Geol. Intern., Vienna, 1903, pp. 694, 695).

In a more extended and later paper,* treating especially the formation of cirques, Richter has explained that his view differs from that of Helland only in ascribing greater importance to weathering upon the cirque walls and less to abrasion upon the cirque floor. Inasmuch as the excessive weathering of cirque walls, as maintained by Richter, is above the surface of the *névé*, a horizontal plane of denudation should develop at that level. No evidence of this plane being discovered, its absence is explained by Richter through abrasion from the snowbank which would collect upon it so soon as formed. This is the fatal weakness of the Richter hypothesis.

Relation of Cirque to Bergschrund.—Up to the beginning of the twentieth century, as we have seen, few geologists had greatly concerned themselves with the erosion conditions at high levels, the work of Richter being on the whole the most comprehensive. The whole subject of cirque erosion was rather generally ignored, as it is indeed to-day. Sir Archibald Geikie, referring to the corries of the Scottish Highlands,† wrote—

"The process of excavation seems to have been mainly carried on by small convergent torrents, aided of course by the powerful co-operation of the frosts that are so frequent and so potent at these altitudes. Snow and glacier ice may possibly have had also a share in the task."

Writing in the same year, Reusch ascribed the Norwegian cirques to the action of surface water descending through the crevasses over falls in the continental glacier which, in Pleistocene times, overrode the country;‡ and the following year, Bonney reiterated his view that cirques were the product of water-erosion.§ Only a few years before, Gannett had curiously explained the origin of cirques through the wear of avalanched snow and ice upon the cirque floor, likening the erosive process to that which takes place beneath a waterfall.‖

The discovery of the method by which the glacier excavates its amphitheatre must be credited to a keen American topographer-geologist, Mr. Willard D. Johnson of the United States Geological Survey.¶ In

* E. Richter, "Geomorphologische Untersuchungen in den Hochalpen," *Pet. Mitt.*, Ergänz. Heft 132, 1900, pp. 1–103, pls. 1–6.

† 'Scenery of Scotland,' p. 183 (revised in 1901).

‡ H. Reusch, 'Norges Geologiske Undersögelse,' No. 32, Aarbog for 1900, 1901, pp. 259, 260.

§ "Alpine Valleys in Relation to Glaciers," *Quart. Jour. Geol. Soc.*, vol. **58**, 1902, p. 699.

‖ "The effect is precisely like a waterfall. The falling snow and ice dig a hollow depression at the foot of the steep descent just as water does" (*Nat. Geogr. Mag.*, vol. **9**, 1898, p. 419).

¶ W. D. Johnson, "An Unrecognized Process in Glacial Erosion" (read before the Eleventh Annual Meeting of the Geological Society of America), *Science*, N.S., vol. **9**, 1899, p. 106; also "The Work of Glaciers in High Mountains" (lecture before the National Geographic Society), *ibid.*, pp. 112, 113. The first public formulation of the doctrine by Mr. Johnson was in an address before the Geological Section of the Science Association of the University of California, delivered September 27, 1892.

fact, to him and to another American topographer, Mr. François E. Matthes, we owe the most of what is known from observation concerning the initiation and the development of the glacier cirque. Reasoning that abrasion was incompetent to shape the amphitheatre, Johnson early surmised that the great gaping crevasse which so generally parallels the cirque wall and is termed the *Bergschrund*, went down to the rock beneath the *névé*, and that it was no accident that glaciated mountains alone "abound in forms peculiarly favourable to snowdrift accumulation." These observations were made as early as 1883, and in order to test his theory, Johnson allowed himself to be lowered at the end of a rope 150 feet into the Bergschrund of the Mount Lyell glacier until he reached the bottom. He found a rock floor to stand upon, and rock extended up for 20 feet upon the cliff-side. We may here quote his terse sentences, since too little attention has been accorded this important observation.*

"The glacier side of the crevasse presented the more clearly defined wall. The rock face, though hard and undecayed, was much riven, the fracture planes outlining sharply angular masses in all stages of displacement and dislodgment. Several blocks were tipped forward and rested against the opposite wall of ice; others quite removed across the gap were incorporated in the glacier mass at its base."

Everywhere in the crevasse there was melting, and thin scales of ice could be removed from the seams in the rock. The bed of the glacier, elsewhere protected from frost-work, was here subjected to exceptionally rapid weathering. By maintaining the rock wall continually wet, and by admitting the warm air from the surface during the day, diurnal changes of temperature here resulted in very appreciable mechanical effects, whereas above the *névé* only the seasonal effects were important.

This observation of Johnson is, it will be observed, in contrast with the suppositions of Richter, who believed that the maximum sapping upon the cirque wall occurred above the surface of the *névé*. The function of the Bergschrund, which separates the stationary from the moving snow and ice within the *névé*, is thus found to be of paramount importance in the shaping of the amphitheatre.

The Schrundline.—That a sharp line is observable in abandoned cirques separating the accessible from the non-scalable portions of the wall, has been pointed out by Gilbert, who has given his support to the view of Johnson, and confirmed it by observations of his own.† Penck, on the other hand, the following year revived the view of Richter that excessive sapping occurs upon the cirque walls *above* the *névé* surface,

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* W. D. Johnson, "Maturity in Alpine Glacial Erosion," *Jour. Geol.*, vol. 12, 1904, pp. 569–578 (read at Intern. Congr. Arts and Sciences, St. Louis, 1904).

† G. K. Gilbert, 'Systematic Asymmetry of Crest-lines in the High Sierras of California," *Jour. Geol.*, vol. 12, 1904, pp. 579–588. See also E. C. Andrews, *ibid.*, vol. 14, 1906, p. 44.

though he calls in the Bergschrund in order to gather in and remove the rock fragments which fall from the cliff.*

Initiation of the Cirque—Nivation.—Johnson's studies upon the processes of cirque shaping, had shown how a nearly perpendicular cirque wall is steadily cut backward through basal sapping at the bottom of the Bergschrund. The problem of how the snowbank, which was the inevitable forerunner of the glacier, had transformed the relatively shallow depression which it presumably discovered into the steep-walled amphitheatre, he did not attempt to solve. Yet the nourishing catchment basin is a prerequisite to the existence of the normal glacier. The solution of this problem has been suggested by another American topographer, Mr. F. E. Matthes.† In the Bighorn mountains of Wyoming he has found exceptional opportunities for this study. Owing to the low precipitation within the region and the consequently inadequate nourishment of

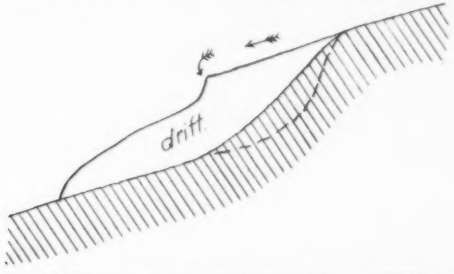

FIG. 2.—CROSS-SECTION OF A STEEP SNOWDRIFT SITE, SHOWING RECESSION BY NIVATION. (AFTER MATTHES.)

glaciers, a large part of the pre-glacial surface still remains. There is, therefore, represented within the district every gradation from valleys which were occupied by snow during a portion only of the year to those which were the beds of glaciers many miles in length. Both small glaciers and high-level drifts of snow still remain in a number of places.

Mr. Matthes has demonstrated that the snowbanks without movement steadily deepen the often slight depressions within which they lie by a process which he has called *nivation*—excessive frost-work about the receding margins of the drifts during the summer season. The ground being continually moist in this belt due to the melting of the snow, the water penetrates into every crevice of the underlying rock, so that it is rent during the nightly freezing. Rock material thus broken up and eventually comminuted is removed by the rills of water from the melting snow.‡ By this process the original depression is deepened, and, if upon a steep slope, its wall becomes recessed (see Fig. 2).

* Albrecht Penck, "Glacial Features in the Surface of the Alps," *Jour. Geol.*, vol. 13, 1905, pp. 15–17.

† François E. Matthes, "Glacial Sculpture of the Bighorn Mountains, Wyoming," '21st Ann. Rept. U.S. Geol. Surv.,' 1899–1900, pp. 167–190.

‡ Mainly in later seasons.

The occupation of a V-shaped valley by snow, as Matthes has further shown, tends through the operation of this process to transform it into one of U-section, since the weathered rock material upon the slopes is transported by the rills and deposited upon the floor. All gradations from nivated to glaciated forms are to be found in the Bighorn range.

During the past field season the writer has taken the opportunity to examine *névé* regions and high-level snowbanks in a number of districts, with the result of confirming the importance of the nivation process as outlined by Matthes. In Figs. 3 and 4 are shown two snowbanks which were photographed on July 25 near the summit of Quadrant mountain, in the Gallatin range of the Yellowstone National Park. The gently sloping surface of this mountain represents the pre-Glacial upland unmodified by Pleistocene glaciation. Though between 9000 and 10,000 feet in height, it supports a rich herbage, and is a favourite grazing-ground of the elk. In Fig. 3 the snowbank is seen surrounded by a wide zone within which no grass is growing, but where a finely comminuted brown soil is becoming a prey to the moving water. Fig. 4 exhibits another bank lying in the depression which it has largely hollowed. At its lower end (at the left) is seen an apron of fine brown mud deposited by the over-burdened stream as it issues from beneath the drift.

An interesting question is at what point the snow-field or *névé* will, by taking on a motion of translation, assume the functions of a glacier. At this stage of transition the Bergschrund should first make its appearance. Comparison of nivated and glaciated slopes in the Bighorn mountains led Matthes to think that upon a 12 per cent. grade the *névé* must attain a thickness of at least 125 feet before motion is possible. Another possible method of approaching this problem has suggested itself to the writer. In mountains like the Selkirks, with steep slopes terraced by the flatly dipping layers in the rock, a peculiar type of small cliff glacier is nourished high above the larger snow-fields of the range and avalanched upon the lower shelves so as to leave vertical sections open to study (see Fig. 5). Perhaps because of their small size these cliff glaciers have not developed cirques, though a Bergschrund parallels the generally straight head-wall. Examined through a powerful glass, the snow in the lower layers can be seen to have lost its brilliant whiteness, though it does not yet appear as ice. A number were examined with a view to determine the approximate minimum thickness of the glacier, but all exceed the minimum estimate of Matthes by at least 100 feet. This is not regarded as in any way discrediting his figure, but rather as suggesting the possibility of more thorough examination along the same line.

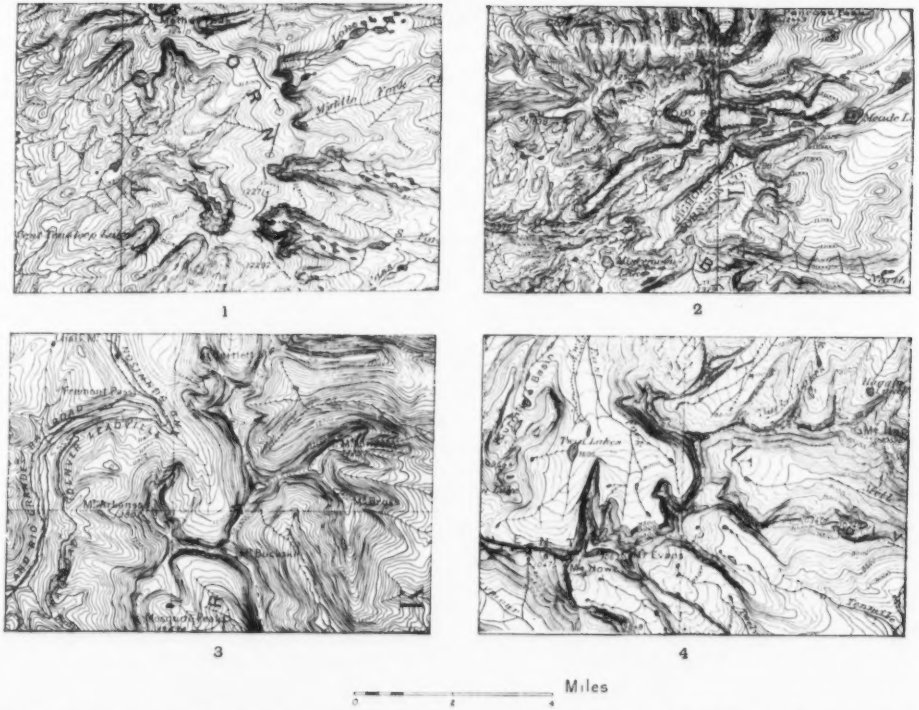

PLATE I.—SERIES OF FOUR MAPS TO ILLUSTRATE THE PROGRESSIVE DISSECTION OF AN UPLAND BY MOUNTAIN GLACIERS.

Fig. 1.—Early stage of glaciation (Cloud Peak Quadrangle, Wyoming).
Fig. 2.—Further investment of the upland, producing a *grooved upland* (Cloud Peak Quadrangle, Wyoming).
Fig. 3.—Early maturity (Leadville Quadrangle, Colorado).
Fig. 4.—Complete dissection at maturity, producing a *fretted upland* (Philipsburg Quadrangle, Montana).

FIG. 3.—SUMMER SNOWBANK SURROUNDED BY BROWN BORDER OF FINELY COMMINUTED ROCK. QUADRANT MOUNTAIN, Y.N.P.

FIG. 4.—SNOWBANK LYING IN A DEPRESSION LARGELY OF ITS OWN CONSTRUCTION. NOTE STREAM OUTWASH OF FINE MUD AT THE LEFT. QUADRANT MOUNTAIN, Y.N.P.

Sculpturing of the Upland.

The Upland dissected.—Having obtained a clear conception of the process of head-wall erosion through basal sapping, Johnson was in a position to account for the topography which he encountered in the High Sierras of California. This topography is best described in his own words *—

"In ground plan the canyon heads crowded upon the summit upland, frequently intersecting. They scalloped its borders, producing remnantal table effects. In plan as in profile, the inset arcs of the amphitheatres were vigorously suggestive of basal sapping and recession. The summit upland—the pre-Glacial upland beyond a doubt—was recognizable only in patches, long and narrow and irregular in plan, detached and variously disposed as to orientation, but always in sharp tabular relief and always scalloped. I likened it then, and by way of illustration I can best do so now, to the irregular remnants of a sheet of dough on the biscuit board after the biscuit tin has done its work."

In a portion of the region where Johnson's studies were made, his views have received verification by Lawson in a beautifully illustrated paper.† Davis has furnished an excellent example from the Tian Shan mountains of the operation of the same cirque-cutting process, recording his adhesion to the Johnson doctrine,‡ though his later papers would indicate that he does not ascribe large importance to the discovery.§

With little doubt the failure to generally recognize the importance of this process of cirque recession, clearly here a more effective agent than abrasion, is to be explained by the fact that in Europe generally, and in the Alps in particular, one looks in vain for evidences of the earlier and more significant stages of the process. Glaciation was here so vigorous as to cause the removal of all summit upland. Within the arid regions of the western United States, a more fruitful field for study is to be found. Here the work of Johnson has been supplemented by that of Gilbert‖ and Matthes.¶ Perhaps nowhere are the early stages of the process so clearly revealed as in the Bighorn mountains of Wyoming (see Fig. 6).

A somewhat more advanced stage of the same process is to be found in the Uinta mountains of Wyoming, recently described in a valuable monograph by Atwood, though here without consideration of the

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* W. D. Johnson, *Jour. Geol., loc. cit.*

† A. C. Lawson, "The Geomorphogeny of the Upper Kern Basin," *Bull. Dept. Geol. Univ. Calif.*, vol. 3, No. 15, especially pp. 357–362 and pls. 32 and 45.

‡ W. M. Davis, "A Flat-topped Range in the Tian Shan," 'Appalachia,' vol. 10, 1904, pp. 279–280.

§ *E.g.*, cf. *Scot. Geogr. Mag.*, vol. 22, 1906, pp. 76–89.

‖ *Jour. Geol., loc. cit.* ¶ *Ibid., loc. cit.*

cirque-cutting process in accounting for the present topography.* Yet nowhere, so far as the present writer is aware, has a view been reproduced which so well illustrates the remnantal tableland and the "biscuit-cutting" process of cirque recession (see Fig. 7).† The present writer has photographed other examples of the same type in the Yellowstone National Park (see Figs. 8 and 14). Remnants of the pre-Glacial surface will, in any given district, be large or small according as nourishment of the glaciers has been insufficient or the reverse. The Uinta range, which extends in an east-west direction, and, like

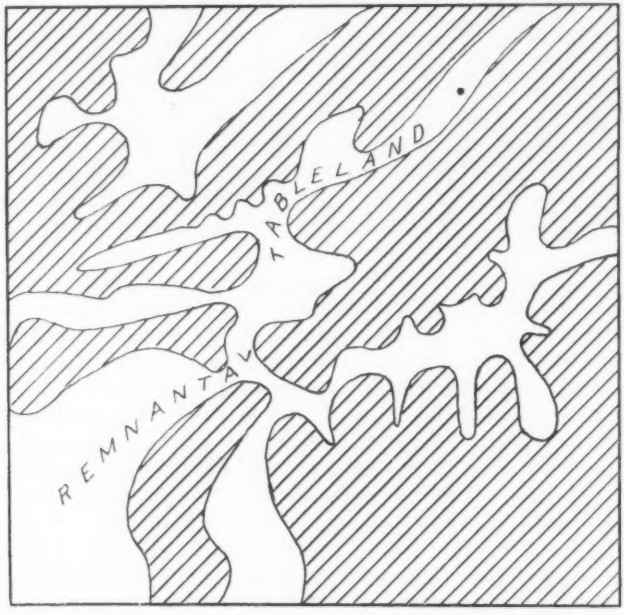


FIG. 6.—PRE-GLACIAL UPLAND INVADED BY CIRQUES, "BISCUIT CUTTING" EFFECT, BIGHORN MOUNTAINS, WYOMING.

the Bighorn mountains, has a core of homogeneous granitic rock, displays this fact. An examination of Atwood's map ‡ shows that to the eastward, where the precipitation has been least, the remnants of the original upland are more considerable. This qualifying condition

* Wallace W. Atwood, 'Glaciation of the Uinta and Wasatch Mountains,' Prof. Paper, U.S. Geol. Surv., No. 61, 1909, pp. 1–96, pls. 1–15.

† Other apt illustrations have been furnished by Lawson in a photograph taken the Upper Kern region of the California Sierras (*loc. cit.*, pl. 32 B), and by Davis in sketch made in the Tian Shan mountains ('Appalachia,' vol. **10**, 1904, p. 279).

‡ *Loc. cit.*, pl. iv.

FIG. 5.—VIEW OF THE YOHO GLACIER AT THE HEAD OF THE YOHO VALLEY, SHOWING TO THE RIGHT A SERIES OF THREE SMALL CLIFF GLACIERS. CANADIAN ROCKIES.

FIG. 7.—VIEW OF THE SCALLOPED TABLELAND WITHIN THE UINTA RANGE, AND NEAR THE HEAD OF THE WEST FORK OF SHEEP CREEK. (AFTER ATWOOD.)

FIG. 8.—PRE-GLACIAL UPLAND ON QUADRANT MOUNTAIN, Y.N.P., INVADED BY THE CIRQUE KNOWN AS THE "POCKET."

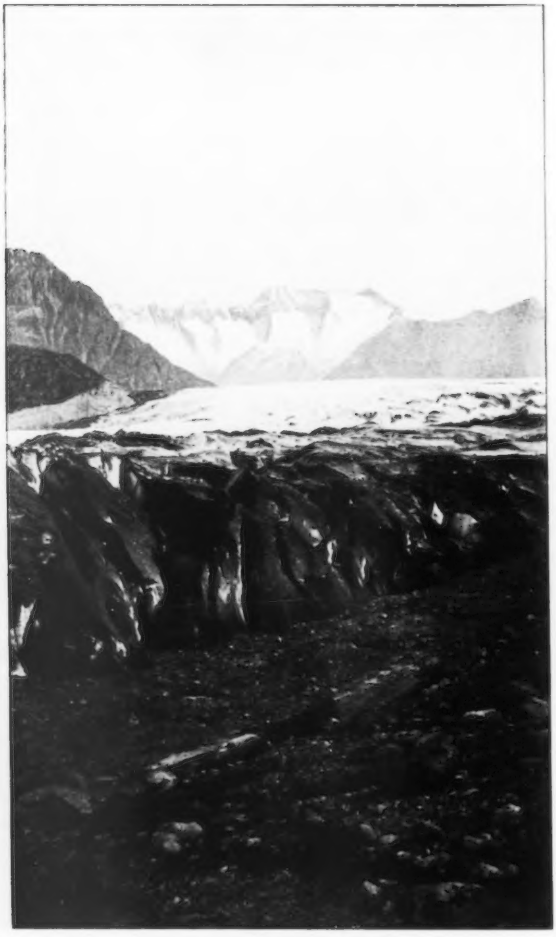


FIG. 11.—MULTIPLE SECONDARY CIRQUE ON THE WEST FACE OF THE WANNEHORN SEEN ACROSS THE GREAT ALETSCH GLACIER, TO WHICH IT IS TRIBUTARY.

of glacier nourishment will be subject to some modification because of peculiarities in snow-distribution. As shown by Gilbert, the first glaciers within any mountain district will probably appear upon that side of the divide which is in the lee of the prevailing winds. This fact is particularly well brought out in Fig. 9.

Modification in the Plan of the Cirque as Maturity is approached.—Owing to the fact that the sapping process within the cirque operates on all sides, its early plan, when the upland surface is supplying snow from all directions, will approach the circle (see Figs. 6 and 8). Moreover, in this stage the cirque will be but little, if any, wider than

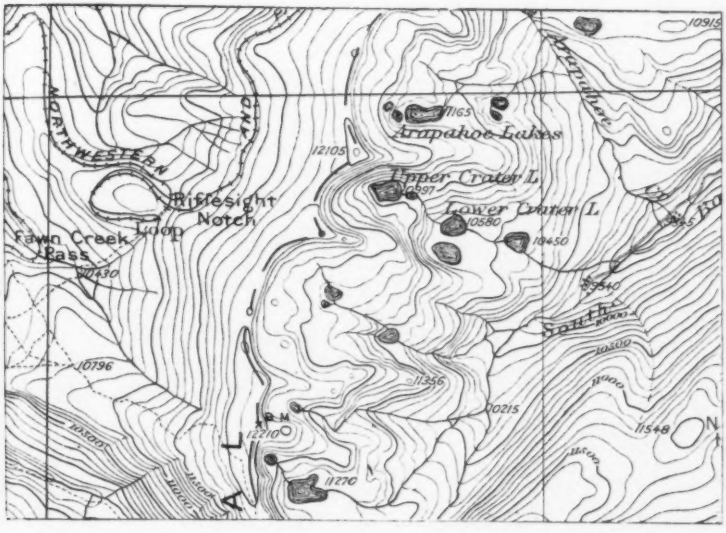


FIG. 9.—SERIES OF SEMICIRCULAR GLACIAL AMPHITHEATRES, WHOSE SCALLOPED CREST FORMS PART OF THE DIVIDE OF THE NORTH AMERICAN CONTINENT. CENTRAL CITY SHEET, TOPOGRAPHICAL ATLAS, U.S. GEOLOGICAL SURVEY.

the deepened and widened valley below (see Plate I., Figs. 1 and 2). Later, with the continuation of the sapping process, the cirque becomes enlarged to such an extent that its sides form recesses in the walls of the valley. Thus, in the plan, the glacial valley of this stage bears some resemblance to that of a nail with a large rounded head.

As the upland is still further dissected, the cirque becomes more irregular in outline and widens into a roughly elliptical form, not infrequently allowing it to be seen that it is in reality composite or made up of several cirques of a lower order of magnitude (Figs. 10–12).

Grooved and Fretted Uplands.—The new emphasis put upon topographic expression of character in the maps issued by Government

bureaus during the past few years, has furnished physiographers a tool of which they are hardly yet fully aware. Before, the aim of topographers seemed to be to suppress all character through a rounding off of angles and an averaging of the data. Perhaps nowhere has the change been more noteworthy than in the maps issued by the United States Geological Survey,* and the later sheets particularly, when relating to glaciated mountain districts, afford us the opportunity of tracing the successive steps in the dissection of such upland districts by the cirques of mountain glaciers. For Plate I. four areas have been selected to represent successive stages in such a progressive dissection.

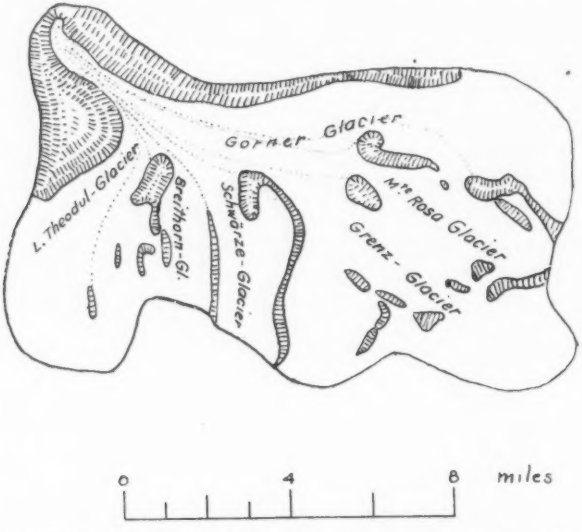


FIG. 10.—OUTLINE PLAN OF ONE OF THE ELLIPTICAL MINOR CIRQUES AT THE HEAD OF THE NICOLAI VALLEY, SWITZERLAND.

An early product in which large remnants of the upland surface still remain, may well be designated a *grooved* or *channelled* surface (see Fig. 13 (*a*)).

As the hemicycle advances, it will be observed that on the flanks of the range are found the largest remnants of the original upland surface (see Fig. 14),† owing to the tendency of the cirque to push

* See D. W. Johnson and F. E. Matthes, 'The Relation of Geology to Topography.' Reprint from Breed and Hosmer's 'Principles and Practice of Surveying,' chap. vii. Wiley & Co., N.Y., 1908.

† Other quadrangles of the U.S. Geological Survey which display the upland surface more or less completely dissected by mountain glaciers are the following: *Early stage*: Younts peak (Wyoming), Marsh peak (Utah-Wyoming), and Georgetown

FIG. 12.—MULTIPLE CIRQUE OF THE DAWSON GLACIER, HAVING A MAJOR SUBDIVISION INTO HALVES, WHICH ENCLOSE RESPECTIVELY THE DAWSON AND THE DONKIN NÉVÉS. THE VIEW IS FROM THE ASULKAN PASS, SELKIRK MOUNTAINS.

(*a*) (*b*)

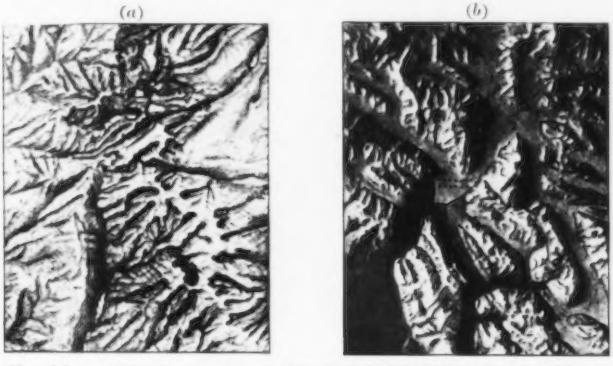


FIG. 13.—(*a*) A GROOVED UPLAND IN THE BIGHORN MOUNTAINS, WYOMING. (*b*) A FRETTED UPLAND, ALASKA.

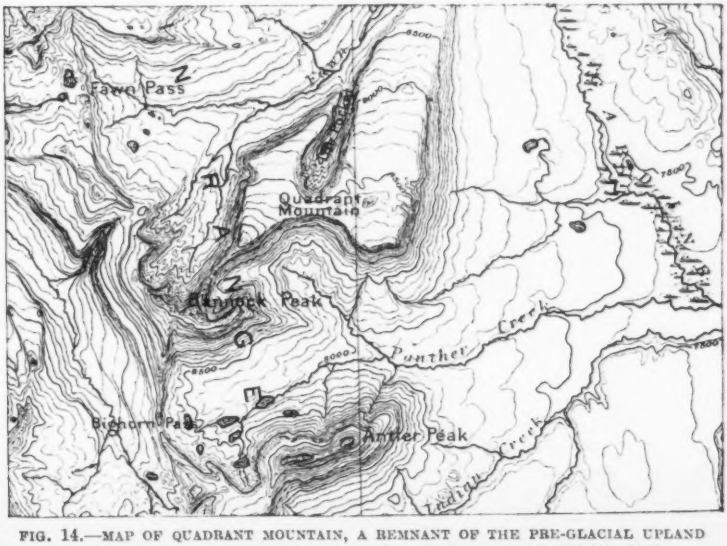


FIG. 14.—MAP OF QUADRANT MOUNTAIN, A REMNANT OF THE PRE-GLACIAL UPLAND ON THE FLANKS OF THE GALLATIN RANGE, YELLOWSTONE NATIONAL PARK.

FIG. 15.—FRETTED UPLAND OF THE ALPS AS SEEN LOOKING NORTH-EASTWARD FROM THE SUMMIT OF MONT BLANC, JULY 25, 1908. THE CIRQUE TO THE LEFT IS THAT OF THE GLACIER DE TALÈFRE, WITH THE JARDIN IN ITS CENTRE, AND DISTANT ABOUT 10 MILES. BOUNDING THIS TO THE LEFT ARE THE ALGUILLE DU MOINE AND THE AIG. VERTE; AT THE REAR ARE THE AIG. LES DROITES AND LES COURTES; AT THE RIGHT IS THE AIG. DE TRIOLET; AND TO THE FRONT THE AIG. DE TALÈFRE, AIG. DE L'EBOULEMENT, AND AIG. DE LESCHAUX.

FIG. 16.—MAP OF A PORTION OF ONE OF THE LOFOTEN ISLANDS, SHOWING A FRETTED SURFACE PARTIALLY SUBMERGED AND EMPHASIZING THE APPROXIMATE ACCORDANCE OF SUMMIT LEVELS.

its side walls out beyond the limits of the U-shaped valley below. With complete dissection of the plateau no tabular remnants are to be discovered. The general level of the district has now been lowered, but above this irregular surface project one or more narrow pinnacle ridges, which at fairly regular intervals throw off lateral palisades having crests which fall away in altitude as they recede from the trunk ridge. In general terms, and describing the major features only, we have here to do with a gently domed surface, on which is a fretwork of comb-like ridges projecting above it. This surface may be designated a *fretted upland* (see Fig. 13 (*b*)). Such a condition is realized in the Alps, and is seen to special advantage from the summit of Mont Blanc (see Fig. 15).

The transition from the grooved to the fretted upland is well brought out in two views taken by Lawson in the High Sierras of California (*loc. cit.*, Plate 45, A and B). The fretted upland differs from the grooved upland of an earlier stage of the cycle in the complete dissection of the surface. The character of the fretted surface is well brought out by the topography of the Lofoten Islands off the arctic coast of Norway, where the effect is somewhat heightened through the submergence and consequent obliteration of the irregularities in the floor (see Fig. 16).

At this stage there is undoubtedly a general accordance of level in the crests of the frets upon the domed surface, as Daly, taking due account of the cirque-cutting process, has claimed.* Moreover, the existence of such a series of frets as are to be found in the Alps, forces us to conclude that such an accordance of summits persists for a considerable time. Were this not the case, we should find a larger number of low cols and a longer persistence of the semicircular form of the cirque. It seems probable, therefore, that a very definite relationship obtains between the plan of the cirque and that of the near-lying upland remnants that contribute snow to its basin. So soon as cirques approach from opposite sides of a divide, the portions of their basins which are more nearly adjacent receive less snow, and, in consequence, accomplish less sapping than the walls on either side where snow is lodged in a quantity but slightly diminished. This self-regulating process will tend to broaden the cirque and eventually give it irregularities of outline dependent primarily upon the initial positions and the individual nourishments of its near-lying neighbours.

Characteristic Relief Forms of the Fretted Upland.—In the earlier stages of mountain glaciation the upland is channelled by valleys U-shaped in

(Colorado); *partial dissection*: Mount Lyell and Mount Whitney (California), Grand Teton (Wyoming), Gilbert peak and Hayden peak (Utah-Wyoming), and Silverton and Anthracite (Colorado); *complete maturity*: Kintla Lakes (Montana).

* R. A. Daly, "The Accordance of Summit Levels among Alpine Mountains: the Fact and its Significance," *Jour. Geol.*, vol. 13, 1905, pp. 117–120.

their upper stretches, and somewhat broadened into steep-walled amphitheatres at their heads. With the complete dissection of the upland, the coalescence of the many cirques at last cuts away every remnant of the original surface and yields relief-forms which are dependent mainly, as already stated, upon the initial positions of the cirques.*

If there be a highest area within the upland, the snow will be carried farthest from it by the wind, and this will be in consequence the last to succumb to the cirque-cutting process. The dome of Mont Blanc in the midst of a forest of pinnacles, no doubt owes its peculiar form to the fact that it dominated the pre-Glacial upland. Elsewhere

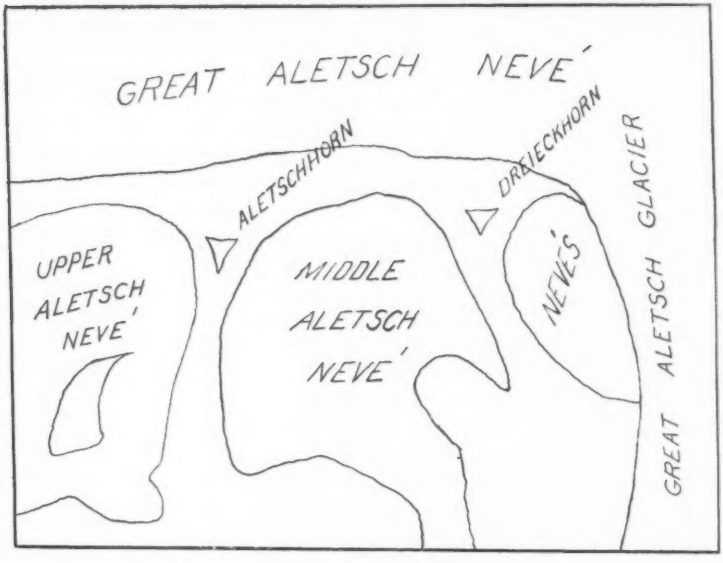


FIG. 17.—POSITION OF THE ALETSCH- AND DREIECKHORNS BETWEEN THE UPPER, MIDDLE, AND GREAT ALETSCH NÉVÉS.

within the upland the coalescence of cirques has produced comb-like palisades of sharp rock-needles which have long constituted the *aiguille*

* The analogy with the forms produced by etching upon crystal faces is so striking that it may be helpful to note it in comparison. The first effect of a reagent in its attack upon the plane of a crystal face is the excavation of deep pits which have a similar and wholly characteristic form, though the surface in other places remains unchanged. These pittings later increase in number, as they do in size, and eventually they mutually coalesce, destroying utterly the original plane surface, and leaving in relief a series of hills and ridges (etch-hills) projecting above a somewhat irregular floor, whose average level is a measure of the average depth of the excavations made by the process. The noteworthy difference between this process and that of cirque recession in glaciated uplands is that the glacial etch-figures are relatively longer and narrower.

type of mountain ridge. In the literature of physiography, such ridges have perhaps most frequently been designated by the term *arête* (fish-bone), though in the Alps the term *grat** (edge) has been applied especially to the smaller and lateral ridges of this type. I propose to use for all such palisades of needles derived by this process the name comb-ridge† as the best English term available. The frequent occurrence of lateral arms joined to the main palisade of needles suggests a differentiation into main and lateral comb-ridges.

In every mountain district maturely dissected by glaciers, are to be found sharp horns of larger base and especially of higher altitude than the individual minaret-like teeth of the comb-ridges. They are further in contrast with the latter by having an approximately pyramidal form, and a base most frequently a triangle with flatly incurving sides. They appear most frequently at the junction points of the comb-ridges between three or more important snow-fields (see Fig. 17). Such forms are generally termed *horns* in the Alps, and the word being of the same form in English, it may well be retained as a technical expression. The Matterhorn in Switzerland is the type *par excellence* (see Fig. 18), though similar and almost equally striking examples are numerous, as, for example, the Weisshorn and Gross Glockner in the Alps, Mount Assiniboine in the Canadian Rockies, or Mount Sir Donald in the Selkirks. The triangular base and pyramidal form are so common to this feature that they have found expression in the local names, as Dreieckhorn, Deltaform peak, etc.

The Col and its Significance.—The prominent horns of any glaciated mountain district no doubt occupy positions corresponding in the main to the more elevated areas in the original upland surface, since such positions would be earliest cleared of snow, and hence latest attacked by the cirques. After complete dissection of the upland the comb-ridges which fret its surface will be attacked from opposite sides, and their crests will be first lowered at the points of tangency of the adjacent cirques—generally near the middle points of their curving outlines. The sky-line of the ridge will thus be lowered in a beautiful curve forming a pass or *col*. Inasmuch as the cirque approaches in its form an inverted and truncated cone of acuminated type, the curve to which the rim of the col approximates will be furnished by the intersection of two cones of revolution with the same apical angle and having parallel axes (see Figs. 19 and 20). This curve is approximately a hyperbola, the

* Very likely originally from *grāte*, fish-bone.

† The use of *combe* in the Jura and the Cote d'Or for different types of valley, or of *coombe* in the Southern Uplands of Scotland for a glacial valley, being each essentially local and having further no relation to the toothed article which suggests the name comb-ridge, does not constitute a serious objection to this choice. Mr. Matthes (and possibly others) have already used the expression comb-ridge in the above described sense ('Appalachia,' vol. **10**, 1904, p. 260).

eccentricity of which will be largely dependent upon the relative sizes of the two cirques in question.

The corries of the Scottish Highlands, being generally of small size, have coalesced to produce a very characteristic scalloping of the horizon line seen to advantage in Ben Nevis, or, better still, in the sculptured gabbro of the Cuchulin hills in Skye.* To judge from views, also, such forms are found in North Wales, features which in many respects are different from those found in the Alps or in the North American mountains.†

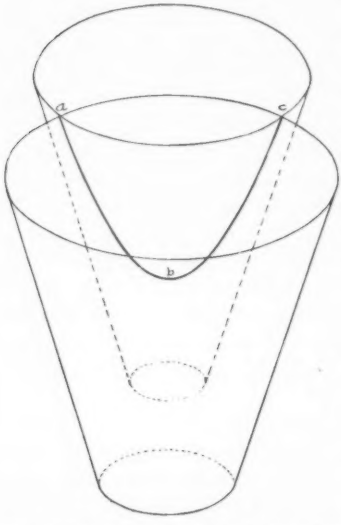


FIG. 19.—ILLUSTRATION OF THE FORMATION OF COLS THROUGH THE INTERSECTION OF CIRQUES.

It must be regarded as of deep significance that mountain passes in areas which have supported glaciers are so generally at high levels. Deep glacier-cut valleys available as highways and transecting high ranges are extremely rare; so far as the writer is aware, being known only from the Southern Andes‡ and Alaska.§ This fact must have its explanation, it is believed, in a notable and abrupt retardation in the rate of cirque-wall recession, following close upon the dissection of the upland. Whether this is due to the reduced snow accumulation immediately beneath the cirque wall owing to the lack of a near-lying collecting ground, it is as yet too early to say; but a comparison of the acclivities in the marginal snow-slopes on *névés* of the Bighorn and Alaskan districts might yield an answer to the question.

Though the sapping process at the base of cirque walls up to maturity is doubtless far more potent than abrasion and plucking upon the floor of the amphitheatre, it seems likely that in the subsequent stage the reverse is the case. This would at least explain the tendency

* See Harker, "Glaciated Valley of the Cuchulins, Skye," *Geol. Mag.* (Fig. 4), vol. **6**, 1899, p. 197; also "Ice Erosion in the Cuillin Hills, Skye," *Trans. Roy. Soc. Edinb.*, vol. **40**, 1901–1902, pp. 234–237.

† This characteristic form of cirque, partly open at the head, is well brought out in a view published by Sir Andrew Ramsey as early as 1852 (*Quart. Jour. Geol. Soc.*, vol. **8**, p. 375).

‡ 'Argentine-Chilian Boundary in the Cordillera de los Andes.' 5 vols

§ R. S. Tarr, "Glaciers and Glaciation of Yakutat Bay, Alaska," *Bull. Am. Geogr. Soc.*, vol. **38**, 1906, p. 149.

FIG. 18.—THE MATTERHORN FROM THE GORNER GRAT, NEAR THE RIFFELHORN.

FIG. 20.—COL OF THE OVERLOOK LOOKING ACROSS THE FOOT OF THE ILLECILLE-WAET GLACIER, SELKIRKS.

of glacier valleys to deepen rapidly in the higher altitudes, or, in Johnson's phrase, to get "down at the heel."

The Advancing Hemi-cycle.—With the augmentation of rigorous climatic conditions within any district where glaciers already exist, the latter will be continually more amply nourished, and must in consequence increase steadily in size. Such climatic changes may even be conceived so considerable that at last the entire range is submerged beneath snow and ice, thus producing an ice-cap.

Direct observation of the successive stages through which glaciers pass from their initiation to their culmination in an ice-cap, is of course impossible, for the reason that we live in a receding hemi-cycle in which practically all known glaciers, instead of expanding, are drawing in their margins; yet a synthetical reconstruction of the life-history is none the less possible. To employ an illustration already used in a different connection, in order to learn the life-history of a particular species of forest tree, it would not be necessary to sit down and observe an individual tree from the germination of its seed to the decadence of the full-grown tree. We may with equal profit go into the forest and observe trees of the same species in all stages of development. In the study of glaciers our opportunity is hardly so fortunate as this, for, as already stated, all glaciers appear to be in the declining stage, whereas it is the advancing hemi-cycle with which we are now concerned. The characters of glaciers as concerns their size and shape depend, however, in so large a measure upon the one element of alimentation, that if we neglect characters of a second order of magnitude, we may by inference construct the history with sufficient accuracy from existing examples.

(*To be continued.*)

SURVEY WORK ON THE BOLIVIA-BRAZIL BOUNDARY.

By Major P. H. FAWCETT, R.A., Chief Bolivian Commissioner.

The Bolivian Boundary Commission continued its labours in 1909, completing the delimitation of the eastern boundary over the ground explored during the latter half of 1906. A sketch of that exploration, together with a *résumé* of the work already completed, was published in the *Journal* of the Society early in 1909.

The repetition of the work was rendered necessary by the unwillingness of the Brazilian commissioner, partly for political reasons and partly owing to the risks entailed in the breaking of unknown country, to join in an exploration which would have completed in one year of work a delimitation for which seven years had been anticipated. As I think I mentioned in the communication referred to, the party of exploration were speeded from Corumba to the utmost limits of civilization

at the old city of Matto Grosso by the expressed conviction that it would never return. In truth, its experiences were not very delectable. Of the six peons who accompanied Mr. Fisher and myself and ultimately struggled back to civilization, five died of the effects. I encountered the survivor, curiously enough a prisoner like myself amongst the Paraguayan revolutionaries, in September last year, and it says much for his pluck that he was willing to repeat the journey. Of actual work there remained little to do. In any case, it is the journey which demands so much in these regions.

A general strike of the entire working population in Buenos Aires in April delayed departure. On my arrival in Corumba the Brazilian Commission was already leaving for the north. After over three weeks spent in the collection of peons and animals, and not twelve hours after the departure of the commission in the wake of the Brazilians, the lighter carrying twenty-nine mules and oxen went to the bottom. Not a single animal survived. I proceeded, however, on the chance of picking up transport amongst the small ranches *en route*, and fortune so far favoured us as to provide, at a price, seven mules, whilst one of the most beautiful mules I have ever seen, ownerless, a simple God-send, walked into a mid-day camp.

We came up with the Brazilians in the old city of Matto Grosso. They had found that the most liberal arrangements could not ensure them a bed of roses, and were waiting in the old city, somewhat uncertain how to proceed. They were fortified with the plans and information of our previous expedition. In the end I took ten Brazilian animals loaded with provisions, some soldiers, and an official, Commandante Lamiña, with my own party direct to the source of the Verde, across the hills of Ricardo Franco. In the previous year we had occupied three weeks of a foodless journey without animals over the exit from the source of the Verde to Matto Grosso by another route; and an International Commission of 1878 had recorded the hills as impassable. It is indeed a route exceedingly complicated, owing to the network of gorges which intersect the sandstone plateau in every direction. The eighteen days occupied by the journey were, I think, amply sufficient for our companions. Meanwhile the Brazilian technical party had left Matto Grosso under the capable direction of Commandante Frederico Oliveira, an experienced Brazilian explorer, following our route of 1908 *viâ* the confluence of the rivers Verde and Guapore.

We reached the source of the Verde on August 10, losing two animals *en route*, it being necessary to overload our own mules in order to help out the Brazilians, who had only donkeys, and whose supplies were important to their main party.

Once at the source, the work was completed in a week. An affluent was discovered which carries the source a trifle further eastward than the position determined in 1908; otherwise, the old work holds good.

The geographical co-ordinates of this region are as under. Matto Grosso, the longitude of which was determined telegraphically from Rio Janeiro by the Brazilian Telegraph Commission, comes within 24″ of arc of that found by me in 1908 ; and the source of the Verde has been referred to it by triangulation.

Matto Grosso	Lat. 15 0 28 S.	Long. 59 57 6
Confluence of the rivers Verde and Guapore ...	Lat. 14 0 2·8	Long. 60 24 16
Source of the Verde	Lat. 14 37 15·2	Long. 60 13 56·2

I had hoped to cross eastwards from the source of the Verde to the hills of the Parecis, traversing that region and returning south by one of the numerous affluents of the Paraguay which flow from that obscure section. All my six peons, however, struck. The Brazilian soldiers had developed scares of savages and filled them with fears. Bribery or cajolement were equally ineffectual. Harsh measures were useless, for they would simply have vanished.

I therefore returned to Matto Grosso, leaving the Brazilians to await the party ascending the river. The return journey only occupied five days—five days of bitter cold, 5° C., with a southerly wind and heavy rain, buried in cloud so dense that 20 yards away an animal was invisible. It was necessary to navigate the plateau, where there is only one route possible for animals, by compass and the plan constructed on the outward journey. At Matto Grosso I found that the Brazilian northern party had suffered misfortunes. The 1908 journey, whose difficulties had certainly been discredited as travellers' exaggeration, was found to be more real than had been expected. The party had been necessarily on foot, carrying all food and instruments on their backs. Commandante Frederico Oliveira himself, whose opinion of the Verde is now strong, had the bad luck to fall into the river in one of the rough gorges, and was forced to return sick with a portion of his escort to Matto Grosso. Two lieutenants, a doctor, and a few soldiers continued the journey without instruments. What their after-experiences were I do not know. They returned to Matto Grosso city, I believe, on September 10, after a journey of nearly two months. Meanwhile my peons culminated their association with the Commission by robbing it of the entire food-supply ; and as Matto Grosso is not a city of desirable residence, I left as soon as possible for the river Paraguay. At San Luiz de Caceres we were upset in mid-river crossing the Paraguay, and by sheer intervention of Providence escaped a tragedy.

I ultimately reached Corumba on September 4. Here plans were completed, and delimitation matters arranged with the head of the Brazilian Commission, who had remained in that city; arrangements being the more simple as the Brazilian Commission had the bad luck to have been unable to get any observations in the Verde, and relations

between the two Commissions had always been of the most cordial nature. The courtesy and experience of the Brazilian commissioner, Admiral Guillobel, and his able staff need no testimony from me. Their work is written on forty years of boundary delimitation. In the valley of the Paraguay 1909 was an exceptionally dry year, hampering the navigation of the river. On September 20 we left Corumba in a small tug for Assuncion, were captured by revolutionaries, and ultimately reached Buenos Aires on October 11, and La Paz on November 9.

At the request of the Government, I have undertaken to explore and delimit the new frontier with Peru, which in the region of the river Heath is still unknown, and to complete the delimitation of the frontier in the Acre, which I explored in 1906 and 1907.

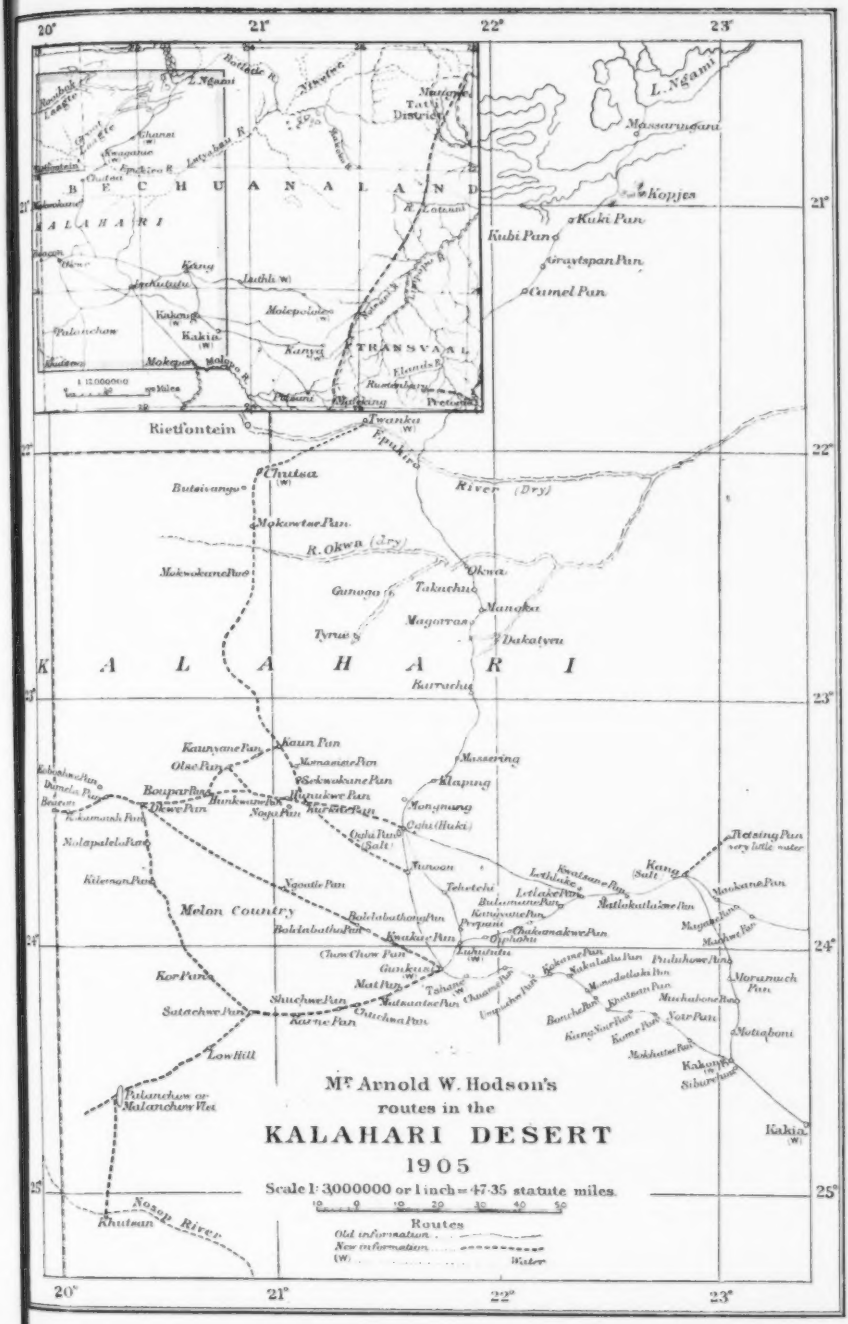
The exploration of the Heath promises to be interesting. It is the happy hunting-ground of the Guarayo Indians, the most hostile and warlike tribe in South America, for which reason it has remained unexplored from a short distance up from its confluence with the Madre de Dios. The Government has considerately agreed to the employment of six ex-soldiers of the British army, in order to minimize the risks and avoid the danger of abandonment by locally contracted peons and Indians in tight places. There will be lucrative employment for them in Bolivia after the work. The Government, moreover, have been so appreciative of the work done as to have commissioned me to arrange for the temporary services of two more British officers for geographical exploration.

I sincerely trust that this little wedge of amity will be followed up. The march of development in Bolivia has been very rapid in recent years. The days of revolutions are past, and no credence must be placed in mischievous exaggerations, such as were cabled from La Paz over the Argentine arbitration award. The country is interesting from any point of view, its officials are broad-minded, and its people most hospitable. I do not hesitate to assert that the country is entering upon an era of most remarkable prosperity.

NOTES ON JOURNEYS TAKEN IN THE KALAHARI DESERT.

By ARNOLD W. HODSON.

THE two chief places from which expeditions, as a rule, start into the Kalahari desert are Molepolole and Kanya. The former is the capital of the Bakwena reserve, and the latter of the Bangwaketse. There are two well-beaten roads from these two places to Lehututu, a place lying about 300 miles west, far into the Kalahari. The country between Lehututu and the German border is practically unknown, and when I first went into it it was shown as a blank on the map. I intend, therefore, to give a short account of the roads from Molepolole and


Mr Arnold W. Hodson's
routes in the
KALAHARI DESERT
1905
Scale 1:3000000 or 1 inch = 47·35 statute miles
Routes
Old information
New information
(W) Water
BECHUANALAND
KALAHARI
TRANSVAAL
L. Ngami
Kuki Pan
Giraffe Pan
Camel Pan
Kubi Pan
Kang
Kakia
Kakia (W)
Kietfontein
Twanka (W)
Chutsa (W)
Butsivangu
Makarutse Pan
R. Okwa (Dry)
Okwa
Ganoga
Takuchue
Manoka
Magorras
Tyrus
Dukatyeu
Kurrutchu
Kaun Pan
Massering
Klaping
Mongnung
Lehututu (Huku)
Salt
Jurwan
Kang Salt
Melsing Pan very little water
Melon Country
Ngoatle Pan
Kor Pans
Satachwe Pan
Low Hill
Lehututu (W)
Gunkung
Matlapi
Tshane
Kakia (W)
Nosop River
Khutsan

Kanya to Lehututu, and a more detailed account of the country lying to the west of it, with a rough sketch showing the places I touched in my wanderings.

On the Kanya road there is water in pits at Sevrelela, Kooi, Sekgoma, and Kakia. From Kakia there is a very long thirst (or dry stretch) to Lehututu, the distance being about 110 miles. These long thirsts are accomplished with a bullock waggon in the following manner. It is difficult to lay down a hard-and-fast rule, as so much depends on the condition of the bullocks, the time of the year, etc. I have always found it the best plan to trek out about 20 miles, outspan, and send the bullocks back to water, letting them rest there a couple of days. The bullocks would then be driven out to the waggon again and inspanned. We would then travel for two nights, when we should be about 20 miles from Lehututu. The bullocks would then be sent on to get a drink and a rest, and after that would be driven back to draw the waggon in. All travelling in the desert is done at night, and the water for one's consumption is carried in barrels under the waggon.

There are a great many pans all along this road, and in the rainy season most of them hold water, so that then travelling is quite an easy matter. These pans are very peculiar. They are all open and quite flat, and perfectly white. I noticed that most of them had a slight rise at their southern extremities. Very often on approaching them you would think they were full of water, the result of the mirage. On the Molepolole road there is water at Metsematluk, Luttli, and brack water at Kang. This road is not so good as the Kanye one, the distances between the wells being greater, to say nothing of the brack water at Kang. The country between Kanye and Kakong consists chiefly of large open plains, on which beautiful grasses flourish, but from Kakong to Lehututu it is thickly wooded, and these woods continue due west right to the German border. The border is the 20th degree of longitude, and is marked at intervals by iron beacons which are numbered, and have the German emblem on one side and the British on the other. The country lying between Lehututu and Damaraland is quite waterless, except, of course, in the rainy season, and one has therefore to depend entirely on melons as a substitute. There are two kinds of melons: one is cultivated, and is called mekatan, and the other grows wild, and is known as kganwe; and of the latter there are two varieties, exactly alike in appearance, but one tasteless and the other bitter like quinine. Animals can eat both, but human beings only the former. There is no way to tell which is which except by tasting. The best way to prepare them is to cut them into slices and boil them in a pot. When they are boiled in this way they give forth a certain amount of liquid, with which you can make coffee or tea. If there is no pot, you cut off their tops and stamp the inside into a pulp, which can then be eaten, and to which the addition of a little sugar is a great improvement.

KAKIA PAN.

KALAHARIS WITH MELONS.

As one travels south-west of Lehututu the country alters completely. It is composed of row after row of sand-dunes, which extend right to the Nosop river. This river, at the point I touched, was just a dry bed with trees growing in the middle of it. These sand-dunes rather give one the impression of the sea on a rough day. This part of the Kalahari is chiefly occupied by the Hottentots, who, accompanied by their cattle and goats, follow the wild melon about from patch to patch. I rode through from Kaun to Choutsa, crossing the Oken river *en route;* this, again, is only a river in name, being quite dry. This was a long and difficult thirst, as we found no melons or water till we reached Choutsa. From Choutsa to Lake Ngami the road offers no difficulties, as there is water in wells at frequent intervals. The principal natives living on the Kalahari are the Mokalahari and the Masarwa. There are also a few Baralongs, etc., living at Lehututu, and a certain number of refugee Damaras. The Mokalaharis are, as a rule, servants to the different Bechuana tribes. They are finely built, but stupid, and seem to have no cares in life so long as they can get milk and an occasional taste of meat. They live in small villages close to the wells, or else out on the melon patches. They look after the Bechuanas' cattle and collect skins, ostrich feathers, etc., for them.

The Masarwas (bushmen) are again subject to the Mokalaharis. They have no fixed habitations, but roam about after the large game, on which they practically live. They are wonderfully clever at trapping the smaller animals, the skins of which they hand over to their masters, the Mokalaharis. They have many strange customs and cures, one of the most peculiar of the latter being, I think, the snake-bite cure. It is made from a small lizard, which they kill and dry. If any one is bitten, they grind a little of this reptile up into powder. They then make two incisions above and below the wound and rub the powder in. The patient also drinks a very little of the powder mixed up in water, and the cure is complete. I have known two bushmen bitten by deadly snakes who used this cure, and on each occasion recovered. Some of them cut open the snake that has bitten them and swallow certain parts of its inside, which they also say acts as a cure. The Masarwa are in appearance slightly built, and have very small hands and feet. Their abdomens, however, are very large, doubtless a provision of nature to enable them to eat at one sitting enough to last them for several days.

The following varieties of large game are found in the Kalahari: eland, giraffe, hartebeeste, blue wildebeeste, kudu, gemsbok, ostrich, springbuck, and the smaller antelopes, such as steinbuck and duiker.

I also obtained specimens of the smaller kinds of animals: banded mongoose (*Crossarchus fasciatus*), sepia cat (*Genetta felina*), striped mouse (*Arvicanthis pumilio*), silver fox (*Fennecus chama*), manhaar jackal (*Proteles cristatus*), bushy tail mier cat (*Eliomys Murinus*), squirrel (*Xerus*

CART IN BED OF NOSOP RIVER.

GROUP OF BUSHMEN.

capensis), Cape jumping hare (*Pedetes caffer*), Cape long-eared fox (*Otocyon megalotes*), vaal bushcat (*Felis caffra*), slender mongoose (*Herpestes gracilis*). Besides these there are many other varieties.

To sum up, given plenty of water, the Kalahari desert would be an ideal cattle country, and probably if water were bored for, it would be found at no great depth.

THE NORWEGIAN SEA.*

Before 1876 the explorations dealt with in the Report by Dr. Helland-Hansen and Dr. Nansen had been confined almost entirely to the outskirts of the Norwegian sea, viz. the sea between Scotland and the Færoes, near the east coast of Greenland, the sea between Spitsbergen and Norway, and the sea off the Norwegian coast. The Norwegian sea itself was practically a *mare incognitum* before the Norwegian *Vöringen* Expedition (1876–1878). From this date up to 1900 many expeditions have collected observations within the basin of the Norwegian sea.

There is no doubt that it is to Dr. Hjort's researches that we are indebted for the splendid results arrived at by the explorations of MM. Helland-Hansen and Nansen. Dr. Hjort's studies in the waters along the Norwegian coast in 1893, and carried on in the succeeding years under his supervision, had been extended to the Norwegian sea. The results obtained were of so much importance that they led to the building of a ship, the *Michael Sars*, to study the problems of the Norwegian sea and bearing more or less on the Norwegian fisheries.

In Chapter II. we find a short account of the cruises during the years 1900 to 1904. Most of the observations discussed have been collected during the cruises of the Norwegian Fishery Research steamer *Michael Sars* during the years 1900 to 1904, and during May, 1901, and May, 1902, between Norway and Iceland, on board the *Heimdal*, of the Royal Norwegian Navy. Special attention has been paid to the work at each station, in order to get the best possible series of observations to show the vertical distribution of salinity and temperature at certain selected points. The distance between the stations was 20 miles, or even less. Since 1902 Danish and Scottish oceanographers have made investigations between the North sea and Iceland, and the authors have made use of these observations in connection with their own for the discussion of the special problems of the Norwegian sea.

The third chapter on instruments and methods is very important. In the case of the central part of the Norwegian sea the salinities are between 34·85 per mille and 35·20 per mille. With such a slight total range in the salinity of the various waters, the seasonal and annual variations are still smaller, and to be detected the most accurate methods must be employed. The accuracy required by the International Council for the Study of the Sea is 0·05 per mille of the salinity. It is, in some cases, not sufficient for the variations of the Norwegian sea. If we take the deep strata of the Norwegian sea below 300 fathoms, I quite agree with

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* 'The Norwegian Sea: its physical oceanography based upon the Norwegian Researches, 1900–1904.' By Björn Helland-Hansen and Fridtjof Nansen. Report on Norwegian Fishery and Marine Investigations. Vol. 2, 1909, No. 2. *With 28 Plates.* Bogtry K. Reri. Kristiania: Het Mallingske. 1909.

the authors when they write, "The quality of the observations, especially in this deep part of the sea, is of much greater importance than their quantity."

During the first cruises of the *Michael Sars* the deep-sea temperatures were taken with the Negretti and Zambra reversing thermometer, and with the insulated water-bottle. During the latest cruises the observations of the temperature of the deep strata have been made with the new Richter reversing thermometer, that can give an accuracy of ±0·01 C. On the other hand, Nansen made a great improvement on the Pettersson insulated water-bottle by fixing a thermometer in the lid of the water-bottle; it is the so-called "Great Nansen insulated water-bottle" (made by Andersen in Christiania), with a capacity of 5 or 6 litres. The Nansen stop-cock water-bottles have been constructed on the principle of the Buchanan stop-cock water-bottle of the *Challenger* Expedition. Attached to the sounding-line, they were of great help in getting water-samples at intermediate depths, and worked very well.

The preservation of the water-samples is of great importance, and the authors recommend the discontinuance of the use of bottles with corks, and the use instead of indiarubber stoppers when the samples have to be stored for more than two weeks.

The Basin of the Norwegian Sea and its Bathymetrical Features.—The Norwegian sea is the whole sea-area enclosed between Norway, the Shetlands, the Færoes, Iceland, Greenland, Spitsbergen, and Bear island. It is divided into three parts: (1) The Greenland sea, between Northern Greenland (north of 71° lat. N.), Jan Mayen, and Spitsbergen; (2) the Iceland sea, between Iceland, Jan Mayen, Greenland (south of 71° lat. N.), and the Iceland-Greenland submarine ridge; (3) the Denmark strait, being a portion of the latter sea, lying between Iceland and Greenland. The fact that the Norwegian sea is situated between the deep North Polar basin and the Atlantic ocean, *i.e.* in the way of the waters travelling between the two seas, has a fundamental effect on its circulation.

Now let us glance at the bathymetrical features of the Norwegian sea as shown on the beautiful map compiled from the latest sources. The floor of the Norwegian sea is divided into two deep basins, viz. the Norwegian deep and the Greenland deep. The map shows very few soundings in the middle part of the Norwegian deep, and, as stated by the authors, it might be that this basin is divided into two portions by a continuous ridge crossing the Norwegian deep from Jan Mayen to the Helgeland coast in Norway. The Greenland deep is separated from the Norwegian deep by "Mohn's transverse ridge" trending from Jan Mayen to the great submarine valley of the Barents sea. The *Belgica* found a hollow 1700 fathoms deep to the north of the Greenland deep, and separated from the latter by a submarine ridge trending westwards from Prince Charles foreland. The most important feature of the Norwegian sea is the submarine ridge known as the "Wyville-Thomson ridge," extending from Scotland to Greenland through the Færoes and Iceland. The greatest depth recorded on the ridge between Scotland and the Færoe bank is 290 fathoms. The Færoe-Iceland ridge forms a fairly level plateau at depths of 200 to 250 fathoms, with a maximum depth of 260 fathoms. The Iceland-Greenland ridge has a saddle-depth of about 300 fathoms.

General Description of the Water-masses of the Norwegian Sea.—The water of the Norwegian sea may be divided into two layers, viz. a surface layer 200 to 250 fathoms deep, and a bottom layer. There is a striking contrast between the physical characters of these two bodies of water; the surface one is heterogeneous, while the lower one is of remarkable uniformity. We find the explanation of this difference in the geographical position of the Norwegian sea.

The different water-masses in the surface layer are—Atlantic water with high

salinity, above 35 per mille; coast water from the North sea, the Baltic, and the Barents sea, salinity below 35 per mille; central water-masses, formed by the mixture of Atlantic water and Polar water, salinity below 35 per mille.

The bottom water representing the bottom layer fills all the deeper parts of the Norwegian sea. It is of constant salinity (a little above 34·90 per mille), and temperature (−1 C.). Thousands of observations led the authors to this very important conclusion, that can be extended to the ocean in general, that *the density gradually increases from the surface to the bottom.*

Chapter vi. deals with the apparent irregularities in the horizontal distribution of temperature, salinity, and density. The equilines (isothermes, isohalines, as well as isopykrals) form bends or undulations like waves, sometimes great, sometimes small. The study of the exact nature and mode of formation of these "waves" and their movements is of great importance. Helland-Hansen and Nansen cannot solve this problem for the present, but they demonstrate how these "irregularities" may be formed in three different ways—(1) by "waves, of some kind, on the boundary between water-strata of different densities; (2) by sudden variation or direction of the surface currents; (3) by great vortex movements or horizontal movements with vertical axes, as shown by the sections of the Lofoten."

To find the solution of the question, oceanographers will have to follow the advice of the authors, "Take as many stations as possible, with the shortest distances between them, and also—at any rate, at some of the stations—repeat as often as possible the observations from the same depths at different hours of the day and night, in order to find out whether the different strata have changed their level during twelve or twenty-four hours." The determination of the distribution and volume of the different waters in the sea depends mostly on the solution of the "oscillations" problem.

The Norwegian Atlantic Current.—The Norwegian current is formed by the entrance of Atlantic water through two openings, viz. the Færoe-Shetland channel and the opening between the Færoes and Iceland, the deepest part of these submarine ridges being not more than 280 fathoms; if we find "35-water" at greater depths, it must be caused by vertical movements of some kind.

The Atlantic water forms cyclonic or anti-cyclonic vortices that carry the water in directions more or less different to that of the Norwegian current. From the study of the equilines, we can summarize the course and extent of the Norwegian Atlantic current as follows: Where a submarine channel exists in the Færoe-Iceland ridge, we find a "tongue" of water with salinities below 34·90 per mille, moving in a southerly direction. The surface layers are checked by the Atlantic water flowing towards the north-east, while the deeper strata advance further south, and it is possible that they cross the ridge and sink in the deep basin of the Atlantic. The Atlantic water immediately to the east of the cold tongue trends for some time in a northerly direction, then is deflected sharply to the east. It passes to the north of the Færoes, and runs into the Færoe-Shetland channel close along the slope of the Færoe platform. The Atlantic water immediately to the west of the "tongue" moves in an anti-cyclonic direction. Along the southern coast of Iceland we find it with a westerly movement.

The main portion of the Norwegian-Atlantic current enters the southern part of the Færoe Shetland channel having a north-easterly direction. It generally keeps to the Shetland bank. Then in the southern part of the Norwegian sea the Atlantic current is made up of water that has come both from the south and the north of the Færoes.

In the Norwegian sea the main body of the Atlantic current keeps close to the continental slope. The western part of it meets the East Iceland Arctic current,

and forms a cyclone in the southern half of the Norwegian sea at from 65° to 66° N. lat. and from 0° to 4° W. long.

Water from the Atlantic current covers the bottom of the deeper hollows and submarine fjords of the continental shelf off western Norway. This Atlantic water (35 per mille salinity) in the fjords and over the continental shelf is always covered by coastal water.

Let us now consider the outflows from the Norwegian sea-basin. (1) The opening between Norway and Bear island, where the water of the North Cape current, eastern branch of the Atlantic current, runs into the Barents sea, either to come back again to the Norwegian sea south of Spitzbergen, or to enter the North Polar basin to return with the East Greenland Polar current. (2) The opening between Spitsbergen and Greenland, that allows the Spitsbergen Atlantic current, the northern branch of the Atlantic current, to enter the North Polar basin. (3) The opening between Iceland and Greenland, through which the main outflow finds its way across the Iceland-Greenland ridge. (4) The opening between the Færoes and Iceland. Only the first two outflows contain a small quantity of Atlantic water, with salinities above 35·00 per mille, proving that the greater part of the Atlantic water entering the Norwegian sea is changed within this sea-area by admixture with other waters.

The surface velocities of the Atlantic current in the eastern part of the Faroe-Shetland channel are of 30 cm.-sec. in May and about 20 cm.-sec. in August, these figures showing a maximum velocity of the current in spring and a minimum in autumn. At 50 or 100 fathoms the velocity is as great as at the surface. The velocity decreases generally from 150 fathoms, down to 200–350 fathoms where the velocity reaches zero.

The investigations of the annual (or secular) variations of the Norwegian-Atlantic current have led the authors to the following conclusions:—

1. "Observations of the mean temperature of the Atlantic water, in the southern Norwegian sea at the surface, as well as in the deeper layers, afford a method of predicting, several months or more, in advance: the anomaly of the air-temperature in Norway, the prospects of the Lofoten fisheries (whether they come early or late), the growth of the fir-wood, the agricultural prospects, and probably also the growth and spawning of the food-fishes, which again determine the fisheries several years later.

2. "Some prognosis of this kind may be based on meteorological observations, but a much greater number of observations, distributed over a large area, would be required, and the mean of even a huge observation-material of this kind would give no more trustworthy prognosis.

3. "The thermal conditions of the Atlantic water are partly of primary, partly of secondary nature, as compared with the thermal conditions of the air in Norway. The conditions under the surface are chiefly primary; they determine the anomaly of the air temperature of Norway, especially in the winter and spring, because different quantities of heat are given off to the atmosphere by the vertical circulation of the water-strata during the cold season. The thermal conditions of the air (and its moisture amount of clouds, etc.) influence the surface temperature of the sea, which so far is secondary. In this manner we find that a *low temperature*, or rather a comparatively *small quantity* of heat, contained in the layers of the Atlantic water *below* the surface should, as a rule, be followed by a low temperature at the surface the following year, and *vice versâ*. This agrees with our observations of the surface temperatures of the four years 1901–1904; but 1905 forms an exception in this as in other respects.

4. "The mean temperatures and the volume of the Atlantic water below the

surface, in a section across the southern Norwegian sea in May, can be used for the prognosis of the character of the air-temperature of Norway in the following winter, the time of the Lofoten fishery (whether early or late) the following winter, probably also the character of the spawning, and the relative quantity of cod-liver.

"The *surface temperature* of the Atlantic water along the same section in May can be used for a prognosis of the growth of the fir wood during the summer a year later, and the quantities of the products of agriculture in the following autumn, in a similar manner as the air-temperature in the spring may be used for the same purpose."

The authors point out that there seems to be a good agreement between the curve representing the variations in quantity of cod-liver and the curve showing the variations in the number of sun-spots, the maximum of cod-liver having a marked tendency to coincide with the minimum of sun-spots. But the periodicity in the sun-spots, or rather in the energy received from the sun, causes variations in the oceanic currents (either directly or indirectly, through the atmosphere), that have a great influence on the climate of Norway and the fisheries, as shown in the above-mentioned conclusions.

The Norwegian Coast Water.—"Coast water" means waters that are found along the coasts with a salinity below 35·00 per mille. The boundary between the Atlantic water and the coast water is generally sharply defined.

The surface salinity along the west coast of Norway, outside the "Skjaergaard," is generally above 31 per mille, increasing towards the Atlantic current. The coast water is moving along the coast of Norway, being a continuation of the Baltic current, from the Skagerack up to the Barents sea. It is worth noting that the average salinity, on the whole, increases along the route of the coast water, while it is the reverse for the Atlantic current. The temperature of the coast water in the Skagerack follows more closely the air-temperature on the Continent than farther to the west and in the Norwegian sea, where the "climate" of the coast water is much more like "oceanic climate" with comparatively small variations.

The coastal current of Norway originates from the Baltic current passing through the Kattegat into the Skagerack. The velocity near the surface is about 1 metre per second. It receives river-water from the fjords.

The variations of the coastal current depend on different factors, as the rainfall and the melting of ice and snow on land, the air-temperature and the insolation. The authors found a very interesting relation between the variation of the coast water and the fisheries of sprat and small herring. Observations during a period of five years show that a small area of coast water (May) corresponds to small catches (autumn) of sprat in the same year, and of small herring in the following year. As the coastal-water variations correspond to the variations of rainfall during the previous year, there should be a correspondence between the rainfall of a certain year and the sprat fishery a year afterwards, as well as the small herring fishery two years afterwards.

Polar Currents.—In chapter ix. we find a description of the Polar currents, based principally on surface observations collected in the Arctic seas by sealing and whaling captains, on observations from Captain Roald Amundsen, and from the *Belgica* Expedition.

The Polar water is a typical coast water, with salinities from 30 per mille at the surface to 34·7 per mille at 90 or 100 fathoms, and with temperatures varying from −1·8° C. to 0° C. The typical feature of the Arctic seas and currents is the presence of an intermediate warm layer between the top layer of Arctic water and the cold bottom layer filling the deeper parts of all northern seas. The presence of

this warm layer is due to the fact that there is a gap in the density between the lighter Polar waters with low salinities and the much heavier bottom water. Waters of Atlantic origin, with densities corresponding to the gap, come from the adjacent seas and flow between these two layers.

There are three Polar currents running into the Norwegian sea: the Bear island Arctic current; the Spitsbergen Polar current; and the East Greenland Polar current. The Bear island Arctic current comes from the Barents sea, and follows the southern slope of Bear island bank. It is composed of Arctic water with temperatures between 0° C. and −1° C., and salinities below 34·7 per mille. This narrow and almost insignificant current often carries ice far towards the south-west of Bear island, and may be dangerous for navigation. The Spitsbergen Polar current runs round South cape, Spitsbergen, and northwards along the west coast, inside the Spitsbergen Atlantic current. It affects the navigation, as it carries ice along the coast, round South cape, in the early summer.

The East Greenland Polar current comes from the North Polar basin; it runs along the north-eastern coast of Greenland, and crosses the ridge between this coast and Spitsbergen, and follows the edge of the Greenland continental shelf southwards. It is composed of cold water with temperatures below 0° C., and with low salinities. If one considers the conditions of motion of this current, it will be found that they are similar to those of the Atlantic current off the Norwegian coast, the greater velocity being limited to the continental slope and the edge of the continental shelf, while the motion is comparatively slow over the shelf. The main body of the current is narrow, and only 100 metres deep. The vertical distribution of temperature and salinity in the cold layer of polar water has the same characters both in the East Greenland Polar current and in the North Polar basin.

The East Iceland Arctic current is formed by admixture of Atlantic water from the Atlantic current, of Polar, Arctic, and Iceland coast water. The authors point out that the designation "Polar" to this current is misleading, as it contains only a small quantity of Polar water. The authors call "Arctic water" the water formed in the Norwegian sea by admixture of Atlantic water with originally Polar water and with water cooled during the winter in the Norwegian sea, and which during the summer may be diluted by the water of the melting ice. The greatest motion of this current is limited to the continental slope on the right side of the current.

The "tongue" of Arctic water over the Færoe-Iceland ridge certainly follows the cyclonic movement of the southern Norwegian sea, and the last traces of its water disappear near the central part of the cyclone, on account of intermixture with the surrounding waters. The "tongue" is formed of Arctic water, evidently coming from the deeper layers of the East Iceland Arctic current.

Ice.—There are two kinds of ice occurring in the region of the East Greenland Polar current, viz. North Polar ice and Arctic ice. The former ice comes from the North Polar basin. It forms extensive floes, 2 to 3 metres thick, with great hummocks 60 to 70 metres thick. The latter ice is formed between Jan Mayen, Greenland, and Spitsbergen, and between Jan Mayen, Greenland, and Iceland. It consists mostly of floes about 1 metre thick, formed during the preceding winter and melting during the following summer. The authors point out the importance of this difference, that has not been taken into account by those who frame theories based upon the variations in the distribution of ice.

The authors are led, by the study of the ice and of vertical temperatures, to the following conclusion: "The cover of ice protects the underlying sea against the cooling by radiation of heat from the surface during the winter, and much heat is moreover disengaged by the formation of new ice."

The Cyclonic Systems of the Southern and Northern Norwegian Sea.—The great primary system of circulation is formed by the Norwegian Atlantic current running along the eastern side-slope of the Norwegian sea, and by the East Greenland Polar current flowing on the western side-slope. It is a cyclonic movement round the whole of the Norwegian sea and basin, along its side-slopes. This primary system is divided into several smaller systems, very likely on account of the topographical features of the sea-bottom. The authors point out how perfectly their chart of the movements in the southern part of the Norwegian sea agrees with Dana's chart of the distribution of *Calanus finmarchicus*, *Calanus hyperboreus*, and *Pseudocalanus*. According to Gran's and Dana's studies, different plankton organisms, like the *Calanidæ*, are characteristic for certain areas in the open sea, where they are stationary. The areas where these organisms have been found correspond exactly to those where the water masses are more or less stationary.

The westerly movement of the Atlantic water in the northern part of the Norwegian sea (about 75° N. lat.) may be compared to the westward movement of the same water west of Lofoten. It coincides in a remarkable manner with the hypothetical low elevation of the sea-bottom off Spitsbergen, trending in a south-western direction.

In the sea west of Spitsbergen the branch of diluted Atlantic water sinks under the Polar current and forms the intermediate warm-water layer. The formation of this branch corresponds to the presence of a submarine ridge trending westwards from the northern end of Prince Charles foreland. The central part of the great cyclonic system of the northern Norwegian sea is the area where the bottom water is formed during the winter.

The Bottom Water.—The formation of ice during winter and spring increases the salinity of the surface water, which then sinks beneath the surface to form at first an intermediate layer. The vertical circulation gradually extends deeper and deeper, until finally what was originally surface water sinks to the bottom, forming a bottom stratum characterized by low temperature (0° C. to −1°·3) and very uniform salinity (about 34·92 per mille).

Nansen pointed out, in 1906, that the bottom water cannot get out of the Norwegian sea. But if this water is warmed up to 0° C. by admixture with the warmer overlying strata, it can be carried out chiefly by the Polar current. On the other hand, very small quantities of bottom water can be formed each winter by the cooling of the sea-surface in such a limited area. The authors conclude that the bottom water of the Norwegian sea, forming the floor of the currents, remains practically unaltered for a very long period of years.

This book throws light into the darkness of the ocean, and will be read with great profit, not only by oceanographers, but also by those who are interested in the problem of the fisheries. Indeed, by the accurate methods employed, Helland-Hansen and Nansen have proved that physical oceanography can and must be an exact science. Their conclusions on the relations that exist between the annual variations of the Norwegian Atlantic current and the Lofoten fisheries, between the variations of the coast current and the sprat and small herring fisheries, are of great value from an economical point of view.

LEON W. COLLET.

REVIEWS.

EUROPE.

Austria-Hungary.

'Austria-Hungary.' By Geoffrey Drage. London: Murray. 1909. Pp. xix., 846. *Maps.* 21*s.*

This is a comprehensive and authoritative volume on a subject which has received by no means too full treatment at the hands of English writers. It is divided into three parts, one being devoted to Austria, the second to Hungary, and the third to the common affairs of the dual monarchy. In each part, history, the people, resources, commerce, and finance are fully dealt with, and there are special chapters on those parts of the empire which demand them—Croatia-Slavonia, Bosnia and Herzegovina—as well as on the region in which the chief external interests of the empire lie—the Balkans. Full use is made of coloured maps. There is only a small general map, as physical description has not a leading part in the scheme of the book, but in connection with the history of Austria there are six maps of Europe at various periods from the Crusades to 1815. They are clearly printed, but would have been improved by explanatory keys to the colouring. The medium of the map is also used to show the distribution of agrarian socialism in Hungary, of races in the empire and in Europe, and of religions in Europe. Appendices provide the student of political geography with ready access to fundamental laws and various important treaties, and the economist with statistical tables, otherwise difficult of access in any form, but here Anglicized, at what must have been considerable labour. There is a full and well-arranged index.

The North European Seas.

'Report on Norwegian Fishery and Marine Investigation.' Vol. 2, No. 1. 1909.

In this monograph, we have a detailed yet concise review of the excellent work carried out on board the s.s. *Michael Sars* between and during the years 1900 and 1908. The area covered extended over the Scottish and Danish waters as far north as Spitzbergen, but the chief efforts of those engaged were concerted upon the Norwegian waters lying between the coasts of Norway and Iceland.

Dr. J. Hjort, in the opening pages, gives an interesting description of the s.s. *Michael Sars*, including a full account of her gear and methods of working. It is, of course, a matter of congratulation that the Government so readily responded to his suggestions to fit out a sea-worthy boat like the *Sars*, specially and fully equipped for the work. He and his colleagues deserve a further word of praise for the excellent results which they have obtained. The work not only embraced fishery experiments of fundamental importance, but interesting ocean research carried out at all seasons of the year and under all conditions of weather. The North sea and Norwegian sea are by no means centres of pleasure-cruising, even in midsummer, and to undertake steady scientific research necessitated a stoutly built boat, a hardy crew, and a stout-hearted scientific staff. Owing to the wide expanse of sea taken in by the Norwegian Fishery Investigations, lying for hundreds of miles along the coast of Norway as far north as Jan Mayen and extending seaward as far west as Iceland, it is hardly possible to run for shelter. This large stretch of water is almost continually swept by storms, which are more or less of a permanent character in winter, and it says much for the staff of the *Michael Sars* that they have been able to accomplish so much.

In the short space at our disposal, it is impossible to even briefly summarize the many additions to our knowledge of the hydrographical and biological

conditions of the North sea that the members of the Norwegian Fishery Investigations have been the means of making. Much has been done by them in studying the temperature, salinities, and current movements, and in planktonic and bottom fauna investigation; also in observing the spawning areas of different fish, and noting the drift or migration of fry and larvæ. That currents have much to do in affecting both the feeding-grounds of the fish and also of the fish themselves is evidenced by the fact that in 1900 the *Michael Sars* found the fry of cod, haddock, and saithe drifting hundreds of miles from their supposed spawning-grounds.

The question of currents is an important one, and is receiving a considerable amount of attention by the International Fishery Investigations. The direction of the main currents in the North sea are now very well known, and also a little about their velocity, which in places is considerable, and must affect the bottom very largely. Less is known of the minor currents, of which there are many in such a shallow body of water. This is shown to a great extent by the patchy nature of the bottom, fine silts and sands cropping out midst coarse grit and gravel. To attempt to map out such a heterogeneous mixture of deposits is almost impossible. It was attempted by Thoulet for the English Channel, but the results were somewhat confusing. The southern portion of the North sea floor is being done in much the same way by the Lowestoft Laboratory of the International Fishery Investigations, but the result will no doubt be somewhat like a Chinese puzzle. R. D.

The Baltic.

'Finnländische Hydrographisch-Biologische Untersuchungen. No. 1. Hydrographische Untersuchungen im nördlichen Teile der Ostsee, im Bottnischen und Finnischen Meerbusen in den Jahren 1898–1904. No. 2. Untersuchungen zur Kenntnis der Wasserbewegungen und der Wasserumsetzung in den Finland umgebenden Meeren, I. Der Bottnische Meerbusen in den Jahren 1904 und 1905.' Erster Teil. Von Rolf Willing. Helsingfors: Helsingin Uusi Kirjapaino-Osakeyhtio. 1908.

The land-locked Baltic sea with its low salinity and large variations, caused by the submarine sills and the fluctuating discharge of the rivers, is an interesting basin to oceanographers, and has been investigated by Swedes, Danes and Germans, and to some extent by Russians. Of late years Finnish hydrographers have taken their full share of the work, having undertaken at the Congress of Naturalists at Stockholm in July, 1898, to carry out soundings and observations in the Gulf of Bothnia, the Gulf of Finland, and the adjoining part of the Baltic. During the years 1898–1904, the number of stations visited was 177, where meteorological observations were made in the air, the temperature of the water noted at different depths, and specimens of water collected. The proportion of chlorium in the water was determined by titration, and hence the salinity was calculated by Knudsen's formula. The analysis of the absorbed gases was performed by Prof. Pettersson's method.

During the years 1904 and 1905 thorough investigations were carried out in the Gulf of Bothnia, and besides the examination of the water, numerous observations were made with a bifilar current meter of Pettersson's pattern, and in 1905 electricity was applied to the registration of the results. The water-level and its fluctuations, with the contributing causes, rainfall, river discharge, wind, etc., were carefully studied, and also the tides. Experiments were made with floating bottles, both free and with weights attached at different depths. A large part of these volumes is taken up with tables of the observations, and numerous maps and diagrams are appended. Other volumes are to follow, and on their appearance it will be possible to obtain a general idea of the results obtained. W. A. T.

'Britain's Sea Story.' By E. E. Speight and R. Morton Nance. (London: Frowde. 1909. Pp. xiii., 427. *Illustrations.* 5*s.*) That a third edition of this collection should have been called for is a tribute to the care exercised by the editors in selecting the extracts from early narratives which form the bulk of the volume. The introduction on ancient and mediæval ship-building is most interesting. The book is designed on popular lines, to which garish coloured illustrations seem almost necessarily, in these days, to belong.

'Great and Greater Britain.' By J. Ellis Barker. (London: Smith, Elder. 1909. Pp. x., 380. 10*s.* 6*d.*) This volume of social, political, and imperial essays appears at an appropriate time. The essayist has the advantage that partisanship is expected of him, and Mr. Barker supports his contentions ably. One may notice here that in his first chapters he introduces as an illustration a concise sketch of mediæval economic geography in Europe, and other similar examples show the wide scope of the work.

'Cambridge County Geographics. Westmorland.' By J. E. Marr. (Cambridge: University Press. 1909. Pp. ix., 151. *Maps and Illustrations.* 1*s.* 6*d.*) This series seems to improve as it grows. In no volume which has been before us hitherto has the text, necessarily compressed as it is, been written with such interest of style, in none have the illustrations been so generally excellent, nor has the impression of value for the remarkably low price been so strongly conveyed. The fine scenery of the county receives full measure of scientific and artistic treatment.

The same. 'Gloucestershire.' By H. A. Evans. (Cambridge: University Press. 1909. Pp. ix., 155. *Maps and Illustrations.* 1*s.* 6*d.*) This volume is also very well written, and nothing could be better than the selection of illustrations, which show very well the scenic and architectural characteristics of the shire.

'Highlands and Byways in Middlesex.' By W. Jerrold. (London: Macmillan. 1909. Pp. xviii., 400. *Maps and Illustrations.* 6*s.*) The present volume will take a high place among those of this well-known series. Mr. Jerrold's style is no less engaging than that of any of his fellow-authors, while Mr. Hugh Thomson's illustrations are better than many others.

'The Isle of Man.' By Agnes Herbert. (London: Lane. 1909. Pp. xvi., 270. *Illustrations.* 10*s.* 6*d. net.*) This is avowedly a "colour-book," and in such the text often has a secondary part. This cannot be said of Miss Herbert's, which is always pleasant reading, though pretending nothing great in the way of scientific or historical worth. Some of Mr. Maxwell's pictures are pleasing, and the book is worth the notice of those who want impressions of the island.

'British Mountain Climbs.' By G. D. Abraham. (London: Mills & Boon. 1909. Pp. xvi., 448. *Illustrations and Diagrams.* 7*s.* 6*d.*) Mr. Abraham has given us good reason to expect an authoritative and attractive volume whenever he deals with this subject. In the present case his object is to provide a handbook of convenient size, and this is done successfully in spite of the large number of pages and the usual clever illustrations from the author's camera. The climbing directions read explicitly, and are arranged on clear topographical plans. References are given to Ordnance Survey maps.

'Conway and Coolidge's Climbers' Guides. The Bernese Oberland.' Vol. 1, part I. By the Rev. W. A. B. Coolidge. (London: Fisher Unwin. 1909. Pp. xxiv., 155. 10*s.*) The new edition of this volume of a well-known series has been carefully rewritten and brought up to date. It is of service not only to climbers, but to ordinary pedestrians as well, and it contains interesting studies of the history of the names borne by the various peaks and passes. While the book

is of unique value in authority, its style of production would seem hardly to justify its price.

'Italy To-day.' By Bolton King and T. Okey. (London: Nisbet. 1909. Pp. xii., 414. 6s.) This volume has already been recognized as an authority on the intricate questions of Italian home affairs, and the new edition has not only been brought up to date, but considerably expanded. The student of economic geography will find here a plethora of facts and figures, the latter properly adapted to English usage.

'Grieben's Guide Books: Lakes of Northern Italy and Milan.' (London: Williams & Norgate. 1909. Pp. 153. *Maps.* 3s.) This seems to be a good ordinary guide, but suffers noticeably from indifferent translation in parts. Its chief recommendation is its handy size.

'Bosnia and Herzegovina.' By Maude M. Holbach. (London: Lane. 1910 (*sic*). Pp. 249. *Map and Illustrations.* 5s.) This volume, with its excellent photographs, gives an attractive account of a country little known to the tourist, but probably soon to become better known. The style is light and pleasant reading, and the book, though mostly a personal narrative, will be found serviceable to intending travellers in the country.

ASIA.

Sikkim and Bhutan.

'Sikhim and Bhutan: Twenty-one Years on the North-East Frontier.' By John Claude White. London: E. Arnold. 1909. 21*s. net.*

A veritable land of enchantment is that far end of the Himalayas which includes Sikhim and Bhutan—of enchantment, that is to say, in all that pertains to those lasting impressions which are derived from the most magnificent scenery that the world can produce. But it must be confessed that the enchantment is largely tempered by certain physical disadvantages, amongst which are to be reckoned a plague of leeches and the persistent trouble of a heavy rainfall. Possibly these two great plagues are intimately related. The memory of Bhutan (across an interval of nearly fifty years) recalls firstly the wide flat spaces of the Duars, thickly covered with dense grass, through which an elephant or a rhinoceros could push his way with difficulty, and beneath which tigers could sneak along the narrow tracks trodden by the hosts of smaller game. Then came the forest growth of the foothills, with magnificent trees and a spread of bamboo jungle such as is unknown in the undulating plains of the Indian peninsula. These filled the low steaming valleys and reached upwards to 10,000 feet of altitude. Beyond this, again, past the forests where the long grey beards of lichen drooping from the branches lent an air of venerable age to the moist scenery, and where leeches curled themselves in myriads in the tangled undergrowth, is the Bhutan of Mr. Claude White, spreading itself in majestic grandeur to the cold passes of Tibet; crowned with a magnificent array of snow-capped peaks, with here and there open valleys and grassy undulations, carpets of flowers, and all the glory of scarlet rhododendrons massed in such a blaze of colour that the eye is almost wearied with its profusion.

Mr. White is by training an engineer whose opportunities of dealing directly with the native officials of this Eastern frontier land specially qualified him for the interesting political duties which he was long ago called upon by the Indian Government to undertake. His sympathetic nature and power of ready adaptability to strange circumstances and surroundings have been valuable assets in the making of his career, but it is only his love of adventure and his deep appreciation of all that is beautiful in nature and art which render him capable of presenting to the public a book so full of interest as that which we have just read. It is not often

that the one man who has the widest and most complete knowledge of his subject is able to render a faithful account of just those special characteristics of it which mark it as distinct from all others; and in this Mr. White has been largely assisted by his quite extraordinary skill as a photographer. Rarely has the beauty of Himalayan scenery been so well illustrated, and never have the idiosyncrasies of a strange people with the specialities of their most interesting form of architecture been so judiciously treated.

Bhutan is a new and strange land to most of us. There is not much literature about Bhutan. Those emissaries of the Indian Government who, at long intervals, have passed through it to Tibet, or endeavoured to frame commercial treaties since the days of Warren Hastings, have described their experiences and coloured their views according to the impressions left by the nature of their reception; and the result has been a very varied and confused general notion of the conditions, natural and social, which govern that country. Mr. White has had every temptation to write in an optimistic vein, for nothing could exceed the personal friendliness towards him which was everywhere expressed; but his observations were close and his mind is judicial, and we may learn from his book quite a new story about Bhutan and the Bhutanese. The only unpleasant reading in the book are the criticisms which he is forced to make on the shifting and unsatisfactory policy of the British Government, which has over and over again left its friends in the lurch, and wasted enormous sums of money over half-completed public works, owing to its fatal want of continuity as regards the north-eastern, or indeed any other part of our Indian frontier. Tibet, as Mr. White points out, is now absolutely Chinese; the Chumbi valley is Chinese, and the Lhasa expedition might never have been. How this will end it is impossible to say, but whilst the attitude of Bhutan towards the Indian Government is (thanks to such men as Messrs. Paul and White) one of friendly aspiration, these hopes are much tempered by their bitter experiences of what they consider to be want of good faith. They are very human, and not at all unreasonable. At present Bhutan may not count for much in Indian politics, but though the day may still be distant, the time will surely come when Bhutan in the north-east will be as important to Imperial interests as is Kashmir in the north-west—and for very similar reasons. It will certainly be a very long time before we are in a position to learn more about this not unimportant corner of the Himalayas than is to be learnt from Mr. White's book. The details of his story may well be left to those who wish to acquire sound information.

T. H. H.

'Through Persia from the Gulf to the Caspian.' By F. B. Bradley-Birt. (London: Smith, Elder. 1909. Pp. x., 331. *Map and Illustrations.* 12*s.* 6*d.*) The author, on a journey homeward from India, travelled up the Persian gulf to Bushire, and thence by Shiraz, Isfahan, and Teheran to the Caspian. His narrative makes interesting reading, and the fact that he claimed the assistance of Sir A. Houtum Schindler adds to the authority with which he writes of Persian social and political affairs.

'An Overland Trek from India.' By Edith F. Benn. (London: Longmans. 1909. Pp. xv., 343. *Map and Illustrations.* 15*s.*) This is an entirely personal narrative, not originally intended, we learn, for publication. The greater part deals with residence and travel in Persia, and as the writer's husband, Major Benn, occupied an official position there, she had peculiar opportunities for gathering knowledge about the country and its people.

'The Face of China.' By E. G. Kemp. (London: Chatto & Windus. 1909. Pp. xv., 271. *Map and Illustrations.* 20*s.*) The author's travels in China have

been extensive, ranging from Peking to the furthest extremity of Yunnan. His chief specialized interest appears to have lain in religious and educational matters. He illustrates his own chapters with a large number of coloured and sepia drawings.

'China: its Marvel and Mystery.' By T. Hodgson Liddell. (London: Allen. 1909. Pp. xiii., 203. *Illustrations.* 21s.) This is primarily a picture-book, and the author-artist's sketches are beautiful and beautifully reproduced. Not only so; speaking purely from the artist's point of view, he broke a good deal of new ground, and though not a few of his scenes are familiar, he presents them, with both brush and pen, in new lights.

'A Scamper through the Far East.' By Major H. H. Austin. (London: Arnold. 1909. Pp. xvi., 336. *Maps and Illustrations.* 15s.) The general character of this book can be guessed from the title: it deals with a journey by the Trans-Siberian railway to Manchuria, and so to Korea and Japan. But the author has a good deal to say on recent and current affairs in the Far East, and his most interesting work in his topographical study of many of the principal battle-grounds in the Russo-Japanese War.

'My Thirty Years in India.' By Sir Edmund C. Cox. (London: Miles & Boon. 1909. Pp. x., 306. *Illustrations.* 8s.) This book deals mainly with personal experiences, but the author's intimacy with Indian police administration enables him to write with authority on some of its problems.

'Thirty-seven Years of Big Game Shooting in Cooch Behar, the Duars, and Assam.' By the Maharajah of Cooch Behar. (London: Ward. 1908. Pp. xxviiii., 461. *Map and Illustrations.* 21s. *net.*) These records of royal sport make a volume as heavy as the reading is light. They will be read with interest, and perhaps envy, by other sportsmen; but the author has not associated any science with his sport.

'A German Staff Officer in India.' By Count Hans von Königsmarck. (London: Kegan Paul. 1910. Pp. xiv., 340. *Illustrations.* 10s. 6*d.*) There is little but personal reminiscence in this volume, though it is a pleasure to read appreciation so unstinted from a foreigner. In his free use of colloquialism the translator has no doubt sought equivalents for the original German.

'The Place of India in the Empire.' By Lord Curzon. (London: Murray. 1909. Pp. 46. 1s.) This is an address delivered before the Philosophical Institute of Edinburgh, and contains a brief but suggestive analysis of the geographical position of India in regard to political and strategical considerations.

'Folk-lore of the Santal Parganas.' By C. H. Bompas. (London: Nutt. 1909. Pp. 483. 10s. 6*d. net.*) This volume consists principally of translations of the original native stories carefully collected and transcribed. They indicate the rich field which awaits investigators in this branch of ethnographical study. Both translations and the brief introduction are admirably done.

'Fryer's East India and Persia.' Vol. 1. Edited by W. Crooke. (London: Hakluyt Society. 1909. Pp. xxxix., 353. *Illustrations.*) John Fryer's narrative of his travels in 1672–1681 is full of interest both in matter and in manner. It is well that it should have been produced with the care which the Society always devotes to its publications. The editor's biographical introduction, moreover, is excellent, and his notes never appear to deserve the charge which he himself offers against them, of unreasonable length.

AFRICA.

African River Vegetation.

'Die Pflanzenbarren der Afrikanischen Flüsse.' (Münchener Geographische Studien, No. 24.) By Oswald Deuerling. München: 1909. 5*s.* 6*d.*

In this monograph Dr. Deuerling has brought together a very large amount of information bearing upon the blocking of river channels by vegetation, and, as the

matter is of no small practical importance in the Nile basin, this work is especially welcome. Marno described the sadd blocks of the Bahr-el-Jebel some thirty years ago, and recently several accounts of the operations undertaken for the purpose of removing these obstructions have appeared, but no full account of them has hitherto been published.

The writer first discusses the various ways in which vegetation may encroach upon areas of open water and upon rivers; in the former he includes marshes and moorlands, the mangrove swamps of the seashore, floating grass and floating islands, such as Chinampai of Mexico, and the periodically "floating land" of Waakhusen, north of Bremen. He next deals with the obstructions formed by vegetation in certain rivers of Europe, Asia, and America, and also in those of Africa, which are treated in greater detail since the instances from the Sudan, from the Congo, from South and Central Africa, and from the upper Nile are treated separately. Finally, the "sadds" of the upper Nile are treated fully, and the character of the region in which they principally occur, their composition, their formation and distribution, and their removal, are all investigated and discussed.

He quotes numerous cases in tropical Africa of the dense growth of papyrus and other hydrophilous plants which reduce the open water-surface of many streams to an insignificant width, the "rush drains" of Speke. The further development of a continuous felted layer of grass vegetation is exemplified by the "*obä*" of the upper Aruwimi river, a tributary of the Congo, where the vegetable covering is tough enough to bear man, but not the heavier quadrupeds, such as the antelope, buffalo, or elephant. Floating islands formed of tree-stems, masses of bank with its vegetation, or grass islands, are likewise alluded to, and their distribution is discussed. Following this an account is given of the barriers of vegetation in Europe, Asia, and America, and a fuller one of their occurrence in the rivers of Africa, where they are more common.

After this preliminary discussion of the characters of these special effects of vegetation and of their distribution and occurrence, a full account of the sadd-blocks of the upper Nile occupies more than half the book. The author protests against the loose employment of the term "sadd" outside its strict meaning of a mass of vegetation blocking a water-way, and quotes an extreme case of misuse where fossil reeds in the Sahara are described by this term of very definite and restricted application.

The physical and climatic conditions of the region of the Bahr-el-Jebel and Bahr-el-Ghazal are set forth fully, both recent work and the accounts of early travellers being utilized, and a full account of the vegetation of the marshes is added, which a special appendix amplifies by furnishing a list of the plants which have been determined from them.

The rest of the memoir is devoted to a full and detailed account of the formation of sadd-blocks, their composition, their distribution, the methods of removing them, and other phenomena connected with this form of interference with the water-system by vegetation. All available sources of information have been utilized. References to such sources are numerous and ample, almost a thousand reference notes being given, and some of them contain indications of several authorities. In this way a valuable summary of information relating to an interesting and important geographical phenomenon has been prepared, and has been brought down to the date of the last published information on the subject. But this is about four years ago, and since then much of the Bahr-el-Jebel and the Bahr-el-Zaraf has been surveyed and levelled, new river-gauges have been established, and measurements of the volume discharged have been made at different seasons. None of those who have a knowledge of this recent work have as yet furnished any account of its

bearing on the interesting geographical problems of this region. There is every prospect of gain from a comparison with regions of similar character, and with increased information the water-logged valleys of these rivers might be profitably contrasted with those of other countries; in such an investigation Dr. Deuerling's work should be most valuable.

The conditions which determine the formation of sadd-blocks and their relative importance are not yet finally determined, and more detailed knowledge gained from accurate surveys may facilitate the solution of this problem. Stormy weather and high water-level, whether from heavy rainfall or from the rise of the Sobat in flood, or both, probably set in motion masses of readily detached vegetation; a winding, narrow river channel affords opportunities for a block being formed; but between this and the gradual closing up a channel by the growth of marsh plants and the drifting in of floating vegetation, there are many stages, and their investigation is a matter of both geographical interest and practical importance, in which full information is essential, and that which has been here collected will be valuable.

H. G. L.

The Oasis of Aïr and its Inhabitants.

'Les Touarag du Sud-Est: L'Aïr. Leur rôle dans la politique Saharienne. Par le Lieut. C. Jean. Paris: Emile Larose. 1909. 12 *fr.*

Lieut. C. Jean's book on the Tuareg of Aïr (or Asbin) is divided into four parts. The first part is a summary of the history of French expansion in the Southern Sahara, and is a useful record of what has been accomplished there since the year 1890. The third part tells of the tentative occupation of Agadez (the capital of the oasis of Aïr) in 1904–5, an occupation rendered definitive in 1906. The fourth part, called an *aperçu* of the *rôle* of the oasis in Saharan affairs, is in reality a discussion of the whole problem of the economic and political development of the central Sahara, that is the region between Timbuktu and Tibesti. This part is notable for Lieut. Jean's frank declaration that, in his belief, a trans-Saharan railway is not needed on political grounds, and would be detrimental to the commercial interests of the Sahara. He argues that the substitution of the railway for the caravan would deprive the Tuareg of their chief means of honest employment, and turn these nomads into simple brigands. In any case, the commercial future of France in West Africa is in its Sudan provinces, and the author is to be commended for his plain words as to the very limited part that the Sahara can play in the development of the French colonial empire. Nevertheless, Lieut. Jean is anxious that France shall do what she can to preserve the caravan trade, and to that end advocates an all-French route between Tunisia and Zinder. He is full of regret that Kano is British, and foresees the economic results which will follow the completion of the railway from the Niger to that city.

The second part of the book, which fills 189 out of its 394 pages, is the most valuable. It is devoted to a description of the oasis of Aïr. After pointing out the strategic and commercial importance which it owes to its geographical situation, the author traces the history of the country. It once formed part of the Songrai empire, though its inhabitants were Hausa, Aïr marking the northern limit of that enterprising people. The only relic of Songrai dominion to-day is the idiom spoken at Agadez and at Mgal, a small town on the route between Agadez and the Songrai capital, Gao. Then came the Tuareg, represented by the Kel (*i.e.* sons of) Gress and the Kel Oui, who, according to Lieut. Jean, made themselves masters of the oasis in the ninth century. This date is probably incorrect—indeed, it is impossible to follow the author in his reconstruction of the history, though he is to be praised for tackling a very difficult subject. From about the year 1300

the story becomes more exact. Certainly Tuareg have for a long period ruled at Agadez. The first sultan is said to have been a son of the Sultan of Turkey by a slave mother, sent to the oasis on the demand of the Tuareg for a ruler whom all could obey. The first armed conflict with the French occurred in 1900; to-day all the various tribes inhabiting the oasis acknowledge French authority.

Lieut. Jean follows his historical inquiries with a chapter on the topography of the country, which he aptly designates the Switzerland of the southern Sahara. He proceeds to depict the aspect of the land in terms that prove him a perfect artist in words. The "tormented mountains," "the wrinkled landscape which has lost its youth," the gorgeous flowers, the swift-flowing streams, all are described in such manner that the reader imagines he sees them before him. And this, perhaps, is the best way of teaching geography. Lieut. Jean, however, does more; he goes on to describe in detail the hydrography, flora, fauna, mineral wealth, climate, industries, and commerce of the oasis. Then follow chapters devoted to the Tuareg their manners, characters, costumes, tribal groupings, religion, and social life. It will be seen that, so far as knowledge of the oasis extends, the book is encyclopædic in its information. Throughout the author keeps himself modestly in the background, though much of the information given is the result of his own investigations. The map of Aïr, drawn by Lieut. Jean, is the best that as yet appeared of the country. Besides maps, there are over a hundred photographs (chiefly of Tuareg), and these add greatly to the worth of a most interesting volume.

F. R. C.

'In the Grip of the Nyika.' By Lieut.-Colonel J. H. Patterson. (London: Macmillan. 1909. Pp. xiv., 389. *Maps and Illustrations.* 7*s.* 6*d.*) This volume will be read with interest by all who are interested in British East Africa, and especially in its game preserves, by sportsmen, and generally by those who appreciate a well-told tale of adventure. The author carried out his researches in connection with game-preservation, and a boundary for the preserve, frequently in difficult, and once in tragic, circumstances. His maps show the geographical value of his work, but they are indifferently reproduced and printed too small.

'In Wildest Africa.' By P. MacQueen. (Boston: Page. 1909. Pp. xiii., 402. *Map and Illustrations.*) This book also deals with a hunting trip in British East Africa and neighbouring territories, but contains in addition some general geographical work, with especial reference to ethnography, together with a short survey of African exploration. There is a considerable (English) bibliography, and a great deal of general information will be found in the text.

'With Mulai Hafid at Fez.' By Lawrence Harris. (London: Smith, Elder. 1909. Pp. xvi., 270. *Illustrations.* 7*s.* 6*d.*) The sub-title of this volume, 'Behind the scenes in Morocco,' indicates its nature. As a newspaper correspondent who obtained the favour of Mulai Hafid, the author had exceptional opportunities for studying the life of the capital, of which little has lately been learnt from experience by Europeans. The book is illustrated with the author's own sketches.

'Les Civilisations de l'Afrique du Nord.' By V. Picquet. (Paris: Colin. 1909. Pp. ix., 396. *Maps.* 4 *fr.*) This is in effect a history of North-West Africa—that part in which France is chiefly interested—from the earliest times. It is a long story to compress into the compass of a small volume, but the author appears to have selected the salient incidents with good judgment.

'The Gateway to the Sahara.' By C. W. Furlong. (London: Chapman & Hall. 1909. Pp. xxvi., 306. *Maps and Illustrations.* 12*s.* 6*d.*) This volume gives a brief historical sketch of Tripoli, and a fairly comprehensive survey of its physical characteristics and the present commercial and political states of its people. The

author's experiences and adventures are well told, and he met with not a few dangers on his journeys.

'The Union of South Africa.' By the Hon. R. H. Brand. (Oxford: Clarendon Press. 1909. Pp. 192. 6s.) This volume, appearing at an appropriate time, is by a writer who served as secretary to the Transvaal delegates at the South African National Convention. Official considerations prevent him from dealing in detail with the discussions of the convention, but he is able to write with peculiar authority about the whole circumstances of the union, surveys the historical circumstances which led up to it, deals in detail with the executive and legislative arrangements, and indicates with first-hand knowledge the popular feeling on the various leading questions of the union.

'Southern Rhodesia.' By Percy F. Hone. (London: Bell. 1909. Pp. xv., 406. *Maps and Illustrations.* 10s. 6d.) We have here an ample volume on "the administrative and industrial development of Southern Rhodesia since its occupation by the British South Africa Company." The writer appears to have had ample assistance from official sources, and quotes fully from original documents. In view of the possible subsequent relations of the territory with the newly formed union, the book appears at an opportune time.

'The Ore Deposits of South Africa.' Part ii. By J. P. Johnson. (London: Crosby Lockwood. 1909. Pp. 51. *Diagrams.* 5s.) This work, of which only the second part is before us, deals in the first with the distribution and character of "base" metals in South Africa. The second deals with the Witwatersrand and Pilgrimsrest goldfields and others. It is a strictly technical work, copiously illustrated with diagrams, including distribution maps, which, however, would hardly be of service to any but metallurgists.

'Great Britain and the Congo.' By E. D. Morel. (London: Smith, Elder. 1909. Pp. xxvi., 291. *Maps.* 6s.) Mr. Morel's attacks on the Belgian "Congo system" command wide attention, and in this strongly worded exposition he is supported by Sir A. Conan Doyle in an introduction.

AMERICA.

Mexico.

'Mexico.' By C. R. Enock. London: Fisher Unwin. 1909. Pp. xxxvi., 362. *Maps and Illustrations.* 10s. 6d.

Mr. Enock's work is already well known through his books on 'The Andes and the Amazon' and 'Peru.' The present volume, like that on Peru, forms one of the "South American Series," under the editorship of Mr. Martin Hume. Mr. Hume contributes an introduction, which consists of a brief survey of what is much more fully elaborated in the text — the history of Mexico down to the present time. To this subject Mr. Enock devotes six chapters, and, besides showing himself to be amply grounded in its study, has evidently a keen eye for its romance. He has no less appreciation for the remarkable scenery and physical peculiarities of the country, which are dealt with in one chapter. Further chapters are devoted to the people, their cities and institutions, to life and travel, mineral wealth, and other resources of the country, its finance, industries, and railways. When a number of good photographs and a large contoured map are taken into consideration, it is seen that we have here an important general treatise on the country, by a writer who has travelled widely in it, has given himself careful training as an observer, and combines with this the interests of a historian and of a business man, so that he is enabled properly to appraise the wealth and

prospects of the country. There is a good index, and a bibliography, in which not all the works mentioned are dated or placed.

Mexico and Yucatan.

'The American Egypt: a Record of Travel in Yucatan.' By Channing Arnold and Frederick J. Tabor Frost. London: Hutchinson & Co. 1909. *Illustrations, Map, and Plans.* 16*s. net.*

It would be difficult for any one with a knowledge of Mexico and Yucatan to write with moderation about the book under review, so indiscriminate and unsympathetic is the treatment that the subject has received at the hands of the authors. No dates are given, but as the authors crossed the Atlantic in November, and had concluded their explorations in Cozumel by the time of the carnival, it may be surmised that the length of their stay in the country did not exceed four months.

One week in the "unpromising land" of Mexico is sufficient to show them that the capital is "a combination of Spanish squalor and Paris-cum-New York civilization—very lightly veneered over in some places."

Nothing appears to have pleased the authors but the tramcar service and the drive to Chapultepec. As for the people, "Burke could not 'find it in his heart to impeach a nation,' but one is sorely tempted to forget his advice in writing of the Mexicans. As a people they are disagreeable. . . . The Spanish Mexicans are sensual and apathetic; avaricious, and yet indolent. . . . The Mestizas—near half the population—have all the worst features of their Spanish and Indian parents."

The Mexicans have their faults, and some of the difficulties in front of them as a nation are sufficiently obvious, but one week's observation appears to be rather a short time on which to frame such a sweeping indictment. The authors go on to describe the habits of the people, discuss the government, and prophesy the speedy absorption of Mexico and Central America by the United States.

The authors took ship from Vera Cruz for Yucatan, and, after a short stay in Merida, proceeded to visit the ruins of Chichen Itza, where they were guests at the hacienda of Mr. Thompson, the U.S. Consul, and then went on to Valladolid. (Do the authors really think that they were the first Englishmen to visit Valladolid? They even forget Catherwood.) Here preparations were made for a journey through the country to El Cuyo (? El Cayo), and thence by boat along the coast to Cozumel. This should be the most interesting portion of the book, for although the route has been described by Stephens and Catherwood, this part of the country is rarely visited. The authors state that they were able to prepare a map of this north-eastern corner of Yucatan, which attains an accuracy no map hitherto published has attained; but, unfortunately, this map is not included in the volume, and no explanation is given of how the survey was made. Some three or four weeks were passed in searching the island of Cozumel for ruins, unfortunately with little result. Rough plans of the two small groups of ruins that were discovered are given on pages 179 and 181. After returning to Merida the travellers visited the well-known ruins of Uxmal, Labna, Kabah, and Sayi.

Two hundred pages are taken up with a description of groups of ruins in Central America extracted from accounts by various authors, but principally from Stephens and Catherwood, and with an attempt to prove that the art of building was introduced into America during the eighth century by a party of Buddhists from Java or India, who came by way of the Caroline or Marshall islands. It is not suggested that they came in considerable numbers, "they possibly numbered two or three hundred." They first built Copan and Quirigua, and then those who lived long enough moved on and built Palenque, Menché, and Piedras Negras!

It is impossible to discuss such a statement in a short review, but it may

be safely asserted that it will not commend itself to any serious student of American archæology. It is supported by statements by various writers, by no means always correctly interpreted, and descriptions and illustrations from Stephens and Catherwood, ignoring to a large extent the great amount of work done since 1840. We may instance the description of the tablet of the cross from Palenque. The authors say, "the right-hand stone has been completely destroyed. Stephens conjectures, probably rightly, that it was covered with hieroglyphics like that on the left." This right-hand slab has been for many years in the National Museum at Washington, and this best known of all Maya monuments has been figured and described again and again.

We may permit ourselves one quotation to show the style of argument employed to support the authors' thesis:—

"In our description of Palenque we have mentioned one of the most curious of all the reliefs—that representing, according to Stephens, women with children in their arms. The Oriental survivals seem to be especially strong at Palenque, and it would not surprise us if in these women-figures there is hidden a cogent proof of the origin of America's first architects. In 'Buddhist Art in Asia,' Prof. A. Grünwedel writes: 'At Sikri, Yusufrai, excavated by Major H. A. Deane in 1888, was found a statue of a woman accompanied by three children, one of which sits astride of her right hip in true Indian fashion, and which she is about to suckle. Among sculptures at Lahore Museum is a statue of a woman completely draped and holding in her left arm a child. It is suggested that these are forms of Haritri, Mother of Demons. She was the mother of five hundred demons, or yakshas, to feed whom she daily stole a child. Buddha rebuked and converted her. An image of her was found sitting in the porch or in a corner of the dining-halls of Indian monasteries, holding a babe in her arms.' Why should not the Palenque figure be a representation of the Hindu goddess Haritri?"

Chapters on the social condition of Yucatan and on the flora and fauna conclude the book.

Before closing this notice we must call attention to the extraordinary letter which the authors saw fit to address to President Diaz on their return to England. As the President naturally took no notice of it, the authors have printed it in their book.

One might be amused at the self-conceit of the whole performance, were it not for the unfortunate results sure to follow. It almost looks as though, having failed to add much to our archæological knowledge, the authors were determined that no one else should have a chance of doing so, for how can a British Minister ever again have the face to ask for facilities or official attention for any Englishman who wishes to visit the more remote parts of Mexico?

It can only be hoped that if this book should ever be read by any English-speaking Mexican, he will understand that it is the expression of individual eccentricity, and that the procedure of the authors would not be endorsed by the many English travellers and residents who have enjoyed the hospitality of that most attractive country.

One ought to add that the authors confess to a very slight acquaintance with the Spanish language. A. P. M.

'The Grizzly Bear.' By W. H. Wright. (London: Laurie. 1909. Pp. x., 274. *Illustrations.* 7*s.* 6*d. net.*) The author has been not only a hunter of the grizzly, but also a scientific investigator. Therefore, in the course of an entertaining narrative, he has much to tell of the present and formerly wider distribution of the animal, its habits, and so forth.

'The Old and New Peru.' By Marie R. Wright. (Philadelphia: Barrie. 1908. Pp. 456. *Map and Illustrations.*) This bulky and very heavy volume contains a careful study of the history and modern condition of Peru, on which, indeed, it should prove a most valuable authority. It treats the modern country from every point of the political, commercial, and social aspects, and is beautifully illustrated.

'The Great Pacific Coast.' By C. Reginald Enock. (London: Grant Richards. 1909. Pp. xi., 356. *Maps and Illustrations.* 16*s.*) The aim of this work—to treat the whole Pacific coast of North and South America "as a physical and political entity"—is certainly bold and original. Perhaps it can hardly be felt that the author welds together the various and widely divergent interests of this vast subject sufficiently closely to justify his object, but whatever opinion may be held on this point, it must be admitted that he omits none of them, and preserves a fair perspective through all. The large and good map of the seaboard and the eastern part of the ocean deserves mention.

'Journal of an Expedition across Venezuela and Colombia.' By Hiram Bingham. (London: Fisher Unwin. 1909. Pp. viii., 287. *Map and Illustrations.* 10*s. net.*) This journey has been dealt with in the *Journal*, vol. **32**, p. 329. It was made with the object of exploring the route of Bolivar's march in 1819, and the battlefields of Boyacá and Carabobo, and was carried out in 1906–7. But the author took the opportunity of making a number of biological and ethnographical observations, and this volume, which is mainly in diary form, is rather of scientific than of historical interest (apart from the mere narrative of the journey, which is well told). There is, however, a short historical sketch in addition to the study of the battlefields mentioned, and, among other results, the observation of weather and temperature regularly made during the journey may be mentioned.

AUSTRALASIA AND PACIFIC ISLANDS.

'Wanderings among South Sea Savages.' By H. Wilfrid Walker. (London: Witherby. 1909. Pp. xvi., 254. *Illustrations.* 7*s.* 6*d.*) The author's experiences extended over Fiji, New Guinea, Borneo, and the Philippines, and his interests would seem to have lain chiefly in the direction of ethnographical study. He and his companions were the first white men to visit and communicate with the peculiar "flat-footed" lake-dwellers, the Agai Ambu, in Papua. In Borneo he saw much of the Dyaks, and also provides an interesting account of the swallow's caves and the native methods of obtaining their edible nests.

'Neuseeland.' By M. F. Blassneck. (Bonn: Brock. 1908. Pp. viii., 139. *Map.*) This dissertation, presented at the University of Bonn, consists of a short general historical, physical, and economic survey of New Zealand. Special mention may be made of the careful and systematic analysis of mineral and agricultural products, in which a full use is made of statistics.

'Across Papua.' By Colonel Kenneth Mackay. (London: Witherby. 1909. Pp. xvi., 192. *Maps and Illustrations.* 7*s.* 6*d.*) The author has not only crossed the British territory in New Guinea in its northerly part, but has coasted practically the whole of it, and visited the D'Entrecasteaux, Trobriand, and other islands. He was occupied on a Royal Commission, but this volume is of course an unofficial narrative. It is full of information about the natives and economic products of the territory.

GENERAL.

'Words and Places.' By the Rev. T. Taylor; edited by the Rev. A. S. Palmer (London: Routledge. [*N.d.*] Pp. xxxvii., 425. *Maps.* 6*s.*) The first edition of

this work appeared in 1864, when, as the present editor points out, the study of place-names was practically untouched. He has carefully annotated those of the author's conclusions which later research does not support. Numerous as these are, the book is a monument of such remarkable care and erudition, with its long list of authorities consulted and its full indices, that a new issue is very welcome.

'Radioactivity and Geology.' By Prof. J. Joly. (London: Constable. 1909. Pp. xiii., 287. *Illustrations.* 7*s.* 6*d.*) This book is a development out of the suggestion that Prof. Joly's Presidential Address to Section C (Geology) of the British Association at Dublin last year should be "rewritten in a more extended and less technical form." A great deal more than mere rewriting, however, has been found desirable, and a good deal of addition has been made to the scope of the address. The geographical distribution of radium, so far as it has been investigated, is dealt with in considerable detail.

'The Natural History of Igneous Rocks.' By Alfred Harker. (London: Methuen. 1909. Pp. xvi., 384. *Diagrams.* 12*s.* 6*d.*) In this comprehensive volume the geographical distribution of volcanic activity is of course dealt with. Some of the diagrams are sketch-maps, illustrating the distribution of igneous rocks and various volcanic phenomena. As blocks in the body of the text, they are particularly well printed.

'The Autobiography of Nathaniel Southgate Shaler.' (Boston: Houghton, Mifflin. 1909. Pp. ix., 481. *Illustrations.* 16*s. net.*) This volume is divided between Shaler's autobiography and a memoir by his wife. His remarkable activity and versatility in geological and geographical writing may be judged from the lengthy list of his publications, and even this is stated to be incomplete. His career, also, was wonderfully varied and interesting.

'Some Principles of Frontier Mountain Warfare.' By Major W. D. Bird. (London: Rees. 1909. Pp. 41. *Maps.* 1*s.*) A brief essay, based upon Indian experience. It contains a few text-maps to illustrate theoretical positions of troops.

'Sailing Ships.' By E. Keble Chatterton. (London: Sidgwick & Jackson. 1909. Pp. xxi., 362. *Plans and Illustrations.* 16*s.*) This treatise on sailing vessels deals with "the story of their development from the earliest times to the present day." It is a story well worth bringing within the compass of a convenient volume, and has clearly necessitated a great deal of research. Much space is devoted to ships of antiquity, and in more modern times warships, trading-vessels, and yachts all receive adequate treatment. The book is profusely and excellently illustrated.

'The Races of Man and their Distribution.' By A. C. Haddon. (London: Milner. [*n.d.*] P. x., 126. *Illustrations.* 1*s.*) This is a handy book of reference to the broad classification and distribution of the races of the world, well arranged and tabulated for ease of reference, and carefully indexed. It is very well produced considering its extremely low price, and should meet with a demand.

'Sport and Travel Papers.' By H. Melladew. (London: Fisher Unwin. 1909. Pp. xii., 336.) This volume, issued for private circulation, shows the author to have travelled very widely in the pursuit of sport: he provides sketches from many parts of Africa, the Americas, the far East, etc., and his sport has been of the most varied.

'W. G. Lawes, of Savage Island and New Guinea.' By Rev. J. King. (London: Religious Tract Society. 1909. Pp. xxvi., 388. *Illustrations.* 5*s.*) This is a record of the life of one of the great missionaries of the Pacific, who died in 1907. The peaceful political settlement of the territory of Papua owed much to him.

'Anson's Voyage Round the World, 1740–1744.' Selections edited by C. G. Cash. (London: Rivers. 1909. Pp. xv., 131. *Map and Portrait.* 1*s.* 3*d. net.*)

There is a clear, brief introduction on the life of Anson and some of his colleagues in this volume, and the selections from Richard Walter's narrative of the voyage are judiciously made.

THE MONTHLY RECORD.

THE SOCIETY.

Commander Peary.—The Council of the Society have decided to award to Commander R. E. Peary a Special Gold Medal in recognition of his long-continued efforts in Arctic exploration, and especially on account of his last expedition, when he succeeded in reaching the North Pole in April, 1909. A silver replica of the Medal will be awarded to Captain Bartlett, who accompanied Commander Peary to 88° N. lat.

EUROPE.

Bornholm.—A careful study of the morphology of the Danish island of Bornholm has been made by Dr. G. Braun (*XI. Jahresber. Geog. Ges. Greifswald*, 1908–09), partly on the basis of his own investigations on the spot, partly on that of the existing literature. He has also had the advantage of information communicated by Dr. Grönwall of the Danish Geological Survey, who is engaged in working up the material collected by that survey. Structurally, the bulk of the island is composed of pre-Cambrian granite, which occupies all its north-eastern part. A characteristic feature of this is the pronounced development of ravines running either north-east and south-west, or at right angles to that direction, as is shown by the courses of the principal rivers. Abutting against the granite on the south is a series of Palæozoic sandstones and schists, followed, after a considerable time-interval, by secondary deposits, chiefly along the south-west coast. Tertiary formations have not hitherto been observed. The whole forms a worn-down stump composed of an ancient land and a coastal plain of composite structure, both placed by dislocations of the crust at about the same elevation, the rectangular form of the island being apparently due to the same dislocations. In course of ages the island has been subject to considerable changes of level, which have in turn increased and reduced its area, the latest movement having been one of elevation. Morphologically, the distinction between the granite and the sedimentary formations is of secondary importance, the action of the ice-sheet having smoothed over the surface of both to a large extent. The coastal plain formed during the course of the various vertical movements has been to a great extent destroyed, but its remnants form a morphological feature, distinct from the earlier land in its mode of origin, but presenting no very marked contrast in its surface features. The line of partition between the two is marked chiefly by the "fall-line" in the course of the southward-flowing streams, due to the elevation of the land during the *Ancylus* epoch, which necessitated a deepening of their channels, with increased fall as they reached the coastal plain. The last section of the paper is concerned with the various forms of the coasts, in relation to the varying geological formations.

Coblenz and its Sphere of Influence.—This subject is ably discussed by Dr. R. Martiny in *Forschungen zur deutschen Landes- und Volkskunde* (vol. 18,

No. 5). Only two or three of the many interesting geographical items in this thoughtful disquisition can be here quoted. The cultural influence of a city hardly admits of definite geographical delimitation. Its range is rather to be likened to concentric rings lessening in intensity from the centre outwards. It is therefore with an admitted element of arbitrariness that Coblenz's cultural influence is limited to an area of some 2000 square miles—a little short of that of the Government district of Wiesbaden and of the Bavarian Palatinate, and about one-hundredth of the German Empire. Enclosed as it is, however, by desolate highlands severing the districts gravitating culturally to Coblenz from the spheres of influence of the next influential towns, this region is so far geographically defined. Only in the valleys of the Rhine, Moselle, and Lahn do the cultural influences from Coblenz and those from other towns clash and mix. This region is the more attractive from the contrast it presents between the vintage of the valleys with its animated bustle, and the poor peasant life of the adjoining highlands—rising to nearly 2500 feet in the Hocheifel—with their heaths and forests. The Rhenish region generally boasts a more ancient culture than the rest of Germany. Down to the present it is distinguished by its material development and affluence, sensuous enjoyment, and business activity. Even in its little towns Rhineland is more urban than middle and east Germany. Through long civic progress its towns have accumulated comparatively large funds, with treasures of art, while the intercourse afforded by their great river has developed in the burgher a special facility in business and affability in manner. Penetrating the country, the Rhenish town-life has turned the peasant into something of a suburban man, innocent of the prejudice against the townsmen cherished by the Bavarian peasant. The vine-dresser is half mechanic and a hard bargain-driver, converting his wine into cash. The law of inheritance assigns to all his children an equal share of his lands. The formation of the Rhenish type of life is attributed principally to the immediate contact with France of a land which, an old Keltic habitat, was the more susceptible to Keltic influences impregnated by Roman culture. Down into the late Middle Ages the left side of the Rhine maintained its cultural superiority. The vine culture of the upper Rhine plain is divided from the agriculture and industry of the lower plain, itself largely infused with town-life, by the slate mountains. These latter are pierced by but a narrow strip of the Rhine valley, giving scope to the formation of no larger town than Coblenz, with its 50,000 inhabitants.

A New Route across the Northern Urals.—In a recent number of the *Deutsche Geogr. Blätter*, of Bremen (vol. 32, part 3), Mr. A. Sibiriakoff calls attention to a route across the Urals, between the basins of the Ob and Pechora, which, he thinks, may in the future attain some importance as a trade route by which the products of Northern Siberia may reach Europe. It connects the navigable waters of the Sosva, a tributary of the lower Ob, and of the Ilych, a tributary of the upper Pechora, by means of tributaries of these streams, which can be navigated by boats to within little more than 100 versts (66 miles) of each other. The land journey is thus shorter than that involved in the case of the frequented route between the Sygva and Pechora, and possesses the additional advantage of being free from the swampy ground which closes the older route during the summer months. In view of the fact that the navigation of the lower Pechora does not open till well on in July, Mr. Sibirakoff points out the advantages to be gained by the construction of a canal between the upper waters of the Pechora and the northern Dwina, which would give access to Archangel, a port already accessible to navigation by early in May. The making of such a canal should be no very difficult matter, as the existing portage between the two basins is only 8 versts (5 miles) in length, while the ground is low and in part sandy.

ASIA.

The Apsheron Peninsula.—A Russian correspondent, Mr. P. Volarovich, writes from Baku giving some of the results, as regards physical geography, of the recent topographical and geological surveys in the Apsheron peninsula and neighbouring parts of the south-eastern Caucasus, undertaken with a view to acquiring a more detailed knowledge of the petroleum-yielding area. They present, he says, a typical picture in miniature of desert relief. The peninsula, though morphologically part of the Caucasus, possesses a climate similar to that of the Trans-Caspian desert region—a high temperature, with evaporation in excess of precipitation. The signs of intensive aeolian activity are very marked, practically the whole relief, both in outline and in detail, being a result of such activity. The one exception is formed by the mud volcanoes, of which there are great numbers. The whole peninsula is without a stream or river system, and even the Sumgait, which forms its western boundary, dries up in summer. All the hollows are a result of wind action. Long deep valleys (true wadis) without any gathering ground for water are to be noticed, as well as broad lake-like depressions (so-called khors), often entirely dry. The destructive action of the wind makes itself visible chiefly along the lines of less resistance, following the strike of the strata, and it is observable that all the forms of negative relief (wadis, denudation valleys, and khors) coincide in direction with the strike. A remarkable instance is the valley of Kirmaku, situated in the centre of the peninsula, and occupying the median line of the Balakhani anticline. The floor of the valley is entirely free from alluvium, and with its horizontal surface forms a huge unbroken trench. The clear-cut crests of the sandstone strata can be distinguished at a distance of some miles. A second example is the great valley of Yasamal, lying west of the city of Baku. It too possesses no collecting basin, and its floor is likewise free from alluvium; but here we have an ancient wadi, and a thin layer of deposits with *Cardium edule* is traceable here and there. The typical forms of desert relief are clearly seen in the new topographical sheets on the scale of 1 : 8400 and 1 : 21,000, brought out by the Geological Committee. The open nature of the country has permitted an exact determination of the structural lines, and the map brings out clearly the close dependence on these of the orographical features of the desert. The tertiary strata of which the peninsula is composed contain much gypsum and chloride of sodium, and fresh water is so scarce that Baku has to obtain its supply from a distance of 100 miles. Recent research has also thrown light on the origin of the extensive deposits of conglomerate which occupy the wide basin of the Kuba district (in the northern part of the Baku government), and attain a thickness of 1000 feet. The surface forms a plateau, dissected by the existing streams, bounded on the north-west and south-west by the massif of the Shah Dagh. These conglomerates are pronounced to be of fluvio-glacial origin. The Shah Dagh was an important centre of former glaciation (though at present only its summit is snow-clad), and the deep and narrow U-shaped valley of Shah Nabat is barred by enormous wall-like moraines. The huge boulder fields of Kuba must have been formed by the impetuous streams which descended from the Shah Dagh.

Prof. Saposhnikoff's Latest Journey in the Altai Region.—This energetic traveller last summer carried out a journey in the Mongolian Altai, by which he has considerably added to the knowledge gained during his earlier journeys (*Petermanns Mitteilungen*, 1909, p. 372). The first part of the journey was devoted to the examination of the snow-covered group of Tabin-bogdo, near the point of junction of the Russian with the Mongolian Altai. At the sources of the Kanas, belonging to the basin of the Black Irtish, an important group of snowy peaks and glaciers was discovered, these being the only glaciers of the

southern side of the range. From Kobdo other explorations were carried out, on the one hand of the White and Black Kobdo rivers and the glaciers connected with them, and on the other of the Dain-gol and of the snow-clad group of Mustau to the south of it. Eventually the professor crossed the Tannu-ola to the upper course of the Kemchik, and thence returned to Tomsk across the western part of the Saian range. Traces of former glaciation were here observed, but the still glaciated groups lay mostly off the route followed.

The Port of Dairen (Dalny).—As one of the main ports of entry into Manchuria, Dairen possesses a particular interest, and the question of its economic development since the Russo-Japanese war is of much importance. A recently issued Consular Report (No. 4372, Annual Series), dealing with the year 1908, permits an estimate of the present position of the port as regards trade and industries. The Consular district of Dairen, comprising the Kwantung leased territory, has an area of 1220 square miles and a population at the end of 1908 of 427,117 (a considerable advance over that in 1907), of whom 29,773 were Japanese. Of the four principal towns, Dairen and its suburb Shaokangtzu accounted for over 41,000, while Port Arthur contained only 13,015. The harbour works at Dairen are still unfinished, and during the rush of the winter season the wharf accommodation falls far short of the needs of the port. An exact estimate of the state of trade is difficult to arrive at, but it may be stated in general terms that the import trade is satisfactory, and the export trade distinctly good. The total showed an advance of over 50 per cent. over that of 1907, Japan taking roughly two-thirds of both imports and exports, for, apart from irregular boats running to Chinese ports, the only means of communication was with that country. So far as imports are concerned, Newchwang still holds the premier place in Manchuria. By far the most important exports from Dairen are beans and bean-cake (the latter used as a fertiliser), the total production of beans having risen from 580,000 tons in 1907 to 830,000 tons in 1908, in which year the beginning was made of a trade with the United Kingdom and Europe. But while there remains a certain area of new land for bean cultivation, it is improbable that the trade will go on increasing indefinitely. It is thought that a prosperous future is in store for the manufacture of bean-cake and bean-oil, and, among other possible industries, the production of wild silk (the defects of which may, it is thought, be removed by a newly discovered process), and the manufacture of soap (from bean-oil), glass, and paper, are mentioned.

AFRICA.

M. Gentil in Western Morocco.—The French scientific traveller, M. Gentil, continued his investigations in Morocco during 1909, and in a communication to the Paris Geographical Society (*La Géographie*, vol. **20**, p. 325) sums up the general results of an interesting journey from Casablanca through the country of the Zaer tribesmen to Rabat, and thence inland to Fez, the earlier section being through country practically unexplored. M. Gentil's competence as a geologist enables him to shed a valuable light on the physical relations of the region visited. The Zaer (whose territory lies north of that of the Shawia) comprise two main divisions—the Mzara and Gefiani, and as they are at feud with each other the traveller was able to traverse the district of the latter only, to whom he had obtained recommendations. The area occupied by the Mzara is a continuation of the littoral zone of the Shawia, and contains the same fertile areas ("tirs") formed by the decalcification, under a moist climate, of the Pliocene limestones of this tract. The country of the Gefiani is more broken, and consists of primary formations similar to those of the mountainous part of the Shawia country. It

is occupied by forests and pasturages, both the cork oak and the *Thuya* being abundant. The pasturelands are mainly granitic, with the typical characters of such a region. M. Gentil pushed inland to the upper valley of the Wad Gru, bordered by a chain which seems to belong to the Middle Atlas. On the way from Rabat to Fez the traveller journeys on the platform of West Morocco as far as the Sebu, and the same platform seems to extend north-east, separating the Riff from the Middle Atlas. In this part of the country the "black lands" of further south give place to less fertile "red lands," which support a less profuse vegetation. The alluvial plain of the Sebu includes, however, some fertile tracts, but of different character and of more local occurrence than in the coastal zone further south.

M. Villatte in the Sahara.—We learn from *La Géographie* (vol. **20**, p. 313) that M. Villatte, whose early surveys in the Central Sahara are known to our readers (cf. *Journal*, vol. **27**, p. 87), returned to Wargla last December after completing a new mission, lasting over a year, to that region. The traveller had carried out a number of astronomical and magnetic observations in the Central Sahara and Northern Sudan, thereby supplying valuable data for the exact mapping of this part of Africa.

The Pacification of Mauritania.—The military column under Colonel Gouraud, to which was entrusted the establishment of French authority over the tribes of the Western Sahara north of the Senegal (cf. *Journal*, vol. **34**, p. 456), completed its work in October last, having dispersed the insurgents by a movement towards the Ijil region, and paved the way for the introduction of a fixed administration suited to the special needs of the country. According to a note in *La Géographie* (vol. **20**, p. 327), Colonel Gouraud has constructed a map of the whole region traversed.

The Nigeria-Kamerun Boundary.—The work of the British and German Commission for the survey of this boundary between the Cross river and Yola was completed during 1909, and some account of it is given by Captain von Stephani, the head of the German party, in the *Deutsches Kolonialblatt* for December 15 last. It was agreed that the two parties should carry out the triangulation independently on the territory of their respective nations, the two nets running therefore roughly parallel to each other, though sometimes overlapping, and linked together at various points. The various means of control afforded showed a most satisfactory agreement between the results of the parties, and the astronomical determinations also agreed well with the geodetic work; while the junction with the Cross river—Rio del Rey section of the boundary, laid down in 1905, was likewise surprisingly good. The new work has also proved the correctness of the determination of the longitude of Yola made in 1903. The labours of the commission were of the most arduous character on account both of the nature of the country and of the climatic conditions, and the health of the members suffered considerably. The escarpments of the tableland of north-west Kamerun extend up to the boundary, and the nearly vertical cliffs could only be climbed with difficulty. The line runs through a country inhabited by a complex of tribes speaking different languages, and intercourse with them was no easy matter. But by the exercise of care and tact friendly relations were on the whole maintained.

The Diamond Fields of German South-West Africa.—Little precise information regarding the newly discovered diamond fields of German South-West Africa has hitherto been available. A concise summary of the history of the discovery and the present state of knowledge concerning the mode of occurrence of the diamonds, contributed to the *Deutsches Kolonialblatt* for November 15, 1909, is therefore of much interest. The author is Dr. Paul Range, whose official

position as geologist to the government of the colony entitles him to discuss the subject with full knowledge. The first discovery, made in April, 1908, in the neighbourhood of Lüderitzbucht, was entirely due to chance, some stones which proved to be diamonds being picked up by a Cape boy, through whom they came into the hands of a German railway official. The most remarkable circumstance is that, during the construction of the Lüderitzbucht railway and the military operations against the Hottentots, thousands had passed over the ground on which the diamonds were lying, and some amount of prospecting for ore had been carried out in the district without revealing the presence of the stones. An important section of the paper is that in which the geological aspects of the question are discussed. The diamonds hitherto found all occur in secondary deposits, every attempt to discover their primary resting-place having proved fruitless. A marked feature is the parallelism of the diamond-bearing deposits with the coast-line, the area occupied by them lying throughout on the seaward side of the sand-dune belt, but extending north and south over a distance of 160 miles. The stones have been found at various altitudes up to about 600 feet. Two theories have been tentatively put forward to account for their occurrence in their present positions. Mr. H. Merensky considers that a series of cretaceous strata have been disintegrated, largely by wind action, leaving the diamonds and the associated pebbles as a small residuum of the original mass. On the other hand, Mr. H. Lotz points to the constant association of the diamonds with small banded agates, commonly cast up by the sea along this stretch of coast, and he suggests that both have been brought down from the basin of the Vaal by the Orange river. Dr. Range does not agree entirely with either of these views. He points out that no Kimberlite or other eruptive rock, such as might have formed the matrix for the diamonds, is known to exist in the region, and that the sea must almost certainly have been the means of transport to the present localities. But it does not appear that agates similar to those found on the south-west coast occur on the Vaal river; while, had the diamonds been derived from the latter locality, there would surely have been some trace of them along the course of the Orange river. He thinks that the diamonds were derived from the denudation of formations originally existing along the coast (probably west of its present position), and since covered by the sea. Since their discovery the monthly yield of the diamond fields has steadily risen, and during the first half of 1909 reached a total of 200,000 carats. Dr. Range considers that the results have exceeded expectation, and that the fields will support a prosperous industry for a number of years.

AMERICA.

Swiss Scientific Expedition to Colombia.—We are informed that a scientific expedition to Colombia is being organized at Neuchâtel, under the auspices of the Société Helvétique des Sciences Naturelles, the leader being Dr. O. Fuhrmann, professor of zoology at Neuchâtel University. It is hoped that a start will be made in July next, and the main objects kept in view will be the study of the fauna of the lakes and rivers of Central Colombia, as well as the parasitic flora, but geological and geographical observations are also contemplated. Dr. Fuhrmann will be accompanied, as botanist, by Dr. Mayor, of Neuchâtel. The Magdalena will be ascended from Baranquilla to Puerto Berrio, whence the party will proceed to Medellin. From this and other centres excursions will be made to various parts of the central Cordillera and the region of the Cauca, the travellers afterwards turning their attention to the Paramos of the eastern Cordillera, and making excursions in various directions from Bogotá. Halts will also be made later at Honda and Puerto Berrio, during the return journey to the coast.

Height of Mount Huascaran.—Mrs. Bullock Workman sends the following communication: "In July last Mrs. F. Bullock Workman sent a party of expert engineers, under direction of the Société Genérale d'Etudes et de Travaux Topographiques of Paris, to Peru to make a reliable triangulation of the height of the two peaks of Mount Huascaran. The head of the mission, M. de Larminat, specially chosen for the work by Messrs. Fr. Schrader and Henri Vallot, has returned, and rendered his preliminary report to Mrs. Bullock Workman, which is as follows: 'The altitude of the north summit of Huascaran, claimed to have been climbed by Miss Peck, of U.S.A., and estimated by her at 24,000 feet, was found to be 21,812 feet. The height of the south summit works out at 22,187 feet.'* The final calculations, which are now being gone over by M. Vallot for verification, may show a variation of a few feet. The full report of the results will be submitted later."

Standard Time for Chile.—It is announced that Chile has now followed the example lately set by Peru (*Journal*, vol. **32**, p. 533), and has adopted, as standard time for the whole Republic, that of the 75th meridian west of Greenwich, or five hours later than Greenwich time. This has everything in its favour from the point of view of practical convenience, as, besides agreeing with the time of Chile's northern neighbour, it is also the time of the eastern United States. It so happens, however, that the 75th meridian passes almost entirely outside Chilean territory, the only parts intersected by it being the peninsula of Taytao and some of the islands lying off the much-dissected southern portion of the coast-line.

AUSTRALASIA AND PACIFIC ISLANDS.

The Mountain Flora of Fiji is described by Miss L. S. Gibbs in the *Journal of the Linnean Society* (Botany), vol. **39**, Nos. 270 and 271, on the basis of collections made by her in 1907 during a residence at the Government station of Nadarivatu, in the north of Viti Levu, not far from the culminating point of the island. The author begins with a general sketch of the physical features of the island, and prints the rainfall observations made by Mr. Joske at Nadarivatu during the years 1901–7. This shows a large variation from year to year, the total fall reaching 163·32 inches in 1901, but only 66·38 in 1903. There is a well-marked dry season lasting from July to October. Climatically, the island may be divided into two main divisions—the windward or south-east portion, including the greater part of the area, with a heavy rainfall and vegetation of tropical luxuriance; and the leeward or north-west side, a narrow belt screened by the mountains from the moisture-bearing south-east trade. By collecting only in the higher grounds, Miss Gibbs was able to eliminate the widely distributed Indo-Malayan littoral flora and the "ethno-botanical" element, both widely distributed. The large number (40) of new species met with in one locality shows that our knowledge of the flora is still too imperfect to admit of definite conclusions as to its relationships, but the collection confirms its Indo-Malayan character (the comparatively low altitude restricting it in the main to forest types), whilst also emphasizing its relationships to the islands to the east—Samoa and Tonga, and to a less extent Tahiti. The relation of the flora to the topographical character of the various islands of this part of the Pacific is very marked. Thus the magnificent conifers of Fiji are absent from the smaller and less mountainous Samoa group, while the flat coral islands of the Tonga group are largely cultivated, Eua only, with its volcanic soil and heavy rainfall, approximating to Fiji in its flora. In

* Mr. C. R. Enock, in his book on Peru, gives the height as trigonometrically fixed at 22,180 feet, a close approximation to the above figure.

plant-dispersal between the islands, wind has played an important part, but the agency of man has been more powerfully operative than has been generally recognized. In Fiji alien weeds are legion, and if no official bar is placed on forest destruction, it bids fair to rival New Zealand in heterogeneous flora and sterile wastes. Among the new records from Fiji are *Melicytus ramiflorus*, widely spread in New Zealand, and also known from the Kermadecs, Norfolk island, and Tonga; *Cyrtandra glabrata*, previously known only from Tahiti; *Podocarpus elatus*, one of the most important forest trees about Nadarivatu, known previously from Eastern Australia and New Caledonia; as well as forms belonging to the Indo-Malayan element. Among the new species is the handsome forest tree *Elæocarpus Kambi*.

Prof. R. Neuhauss in German New Guinea.—Prof. Neuhauss has communicated to the Berlin Geographical Society, of which he is a member, a short account of journeys carried out by him in 1908 and 1909, in German New Guinea, chiefly in the region of Huon gulf and the peninsula bounding it on the north. From Finsch haven, in company with Herr Keysser, a missionary, he went inland some 40 miles through a wild and rough mountain region traversed only by the hardly distinguishable paths of the natives, habitations of whom were found to an elevation of 4600 feet, the interior being much better peopled than has been supposed. The traveller collected material for an accurate map of Kai-land, the peninsula north of Huon gulf. In May and June, 1909, he ascended the Markham to a higher point than had previously been reached, finding it a well-defined stream, several hundred yards broad, and navigable for native canoes at least 60 miles from its mouth. At the time of writing the traveller was near the Dutch boundary, where he observed the effects of an earthquake that took place in 1907. For several miles the coast sank a considerable number of feet, palm trees and native dwellings being now covered by the sea.

Monument to Bougainville at Tahiti.—On July 14, 1909, a monument to the great French navigator was inaugurated, with appropriate formalities, at Papeete, on the island of Tahiti, which island he visited only a few months after its discovery by the English navigator Wallis. The proposal for the erection of the monument emanated from a French colonial official, a member of the Paris Geographical Society, by which body it was taken up with enthusiasm. The bust erected at Papeete was in part a copy of that in the possession of the Paris Society, but portraits preserved in the navigator's family were also utilized by the sculptor. The scheme received the support of the French Government as well as of the municipality of Papeete, and the ceremony of inauguration was opened by a speech by M. François, Governor of French Oceania. Two French and two British warships were present on the occasion.

POLAR REGIONS.

Peary and Cook.—In summarizing the North Polar narratives of Commander Peary and Dr. Cook in the October number of the *Journal* (vol. **34**, p. 433), we expressly reserved all comment till fuller information should become available, adding that the final decision with respect to the claims of both explorers must await the examination of their scientific observations. Commander Peary, immediately after his return, submitted all his records for examination to the National Geographic Society of Washington, and the report of its sub-committee, the names of whose members speak for their competence, was published in the last number of the *Journal*. It is with pleasure that we are able to announce that Commander Peary will lecture on his expedition at a special meeting of the Society to be held in the Royal Albert Hall on May 4. On Dr. Cook's arrival in Copenhagen, he

announced that he had been obliged to leave his original records at Etah in charge of a fellow-countryman, Mr. Harry Whitney, who had been on a sporting trip to Greenland, but he promised at the earliest possible moment to submit to the University of Copenhagen a report which would fully substantiate his claim. After a delay of over two months, Dr. Cook despatched his promised report to the University of Copenhagen, and on December 21 the University Council announced the result of the examination of the report by the special committee appointed for the purpose. The copy of Dr. Cook's notebooks which had been sent to the university contained no astronomical records, but only results, and the committee stated that there were no elucidatory statements which might have rendered it probable that astronomical observations had really been taken. Nor were any practical details of the journey supplied such as would enable the committee to form an opinion relative to Dr. Cook's claim. The committee therefore considered that from the material submitted no proof could be adduced that Dr. Cook had reached the North Pole. Early in January it was reported that Dr. Cook's original notebooks had arrived in Copenhagen. On January 19, the Council declared that these notebooks were, in all essential particulars, identical with the copy on which the University based their judgment in the first instance. They find that the evidence submitted contains not the slightest proof that Dr. Cook reached the North Pole, nor, they state, is there any decisive proof to the contrary. The University, therefore, intends to take no steps at present with regard to the Honorary Degree conferred on Dr. Cook. A committee of the Explorers' Club, New York, appointed to examine Dr. Cook's claim to have ascended Mount McKinley in 1906, has drawn up a report unfavourable to the claim.

Amundsen's North Polar Expedition.—It is stated in *Petermanns Mitteilungen* that Captain Amundsen has modified his plans to the extent of postponing his departure from Norway till June of this year, and his final passage of Bering Strait till August, 1911, devoting most of the intervening period to oceanographical research in the South Atlantic during the outward voyage. He also proposes to carry out extensive investigations of the upper atmosphere during the drift across the Polar basin.

Government Grant to Captain Scott.—It is with great pleasure that we announce that Captain Scott has received a letter from the Treasury informing him that Parliament will be asked next session to vote a grant of £20,000 towards the cost of the South Polar Expedition which he is now engaged in organizing. In announcing his plans last autumn, Captain Scott estimated that their realization would involve a total expenditure of £40,000. Towards this amount there has now been subscribed and promised a sum of £31,000, including the Government grant. It will thus be seen that a sum of £9000 is still required to make up the minimum estimated cost of the expedition. No doubt as plans develop and work expands, Captain Scott will find that £40,000 is all too small a sum to meet his requirements. It is highly desirable that at least that amount should be subscribed in this country, leaving any grants which may come from the Australian and New Zealand Governments, in pursuance of the policy of generous assistance which has been followed by those countries in connection with the *Discovery* and *Nimrod* expeditions, to meet the excess of actual over estimated expenditure which is practically inevitable in such cases. It has been definitely decided to make Christchurch, New Zealand, the base of the expedition's operations.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Valley Tracks and Vegetation.—The above is the title of an article by Mr. G. F. Scott Elliot in the *Scottish Geographical Magazine* for August, 1909.

The phenomena dealt with are the formation of new land in river valleys and its fixation through the agency of colonizing plants. In the first place, the silt and sand brought down by rivers in the early "torrential" part of their course through woodland or peaty (moorland) regions is of a very mixed character, and is often of great fertilizing value—a fact made use of in Italy, where care is taken to deposit the silt of mountain streams on prepared surfaces to improve the character of the soil. If a river is selected and followed downstream, it is found that the width of the valley flats and the height of its banks gradually increase. The first stage in the formation of a river flat seems to be due to some rock-barrier downstream damming up the river when in flood, or, at any rate, interfering with the free passage of the flood-water. On the flooded lands beside the river, the water, being brought to rest, deposits its floating material, giving rise in summer to a rich growth of vegetation, which, by the following winter floods, is again covered with fine mud and sand. In this way a young holm, which may be covered by nothing but marsh and rush vegetation, will gradually develop into a hay meadow. It is, however, towards the river-mouth that the most important processes of land-formation are being actively carried on. When the silt-laden chocolate- or coffee-coloured water, passing straight down into the estuary, meets the constantly changing currents of the sea-water, its flow is checked, and as a consequence sand, and then mud, sinks and accumulates in an intricate series of submerged banks. In the Solway estuary the process is complicated by strong and irregular currents, and colonization by plants is rendered very difficult by the well-known "bore," or tidal wave. At considerable depths below high-water mark a certain amount of fixation may be effected by the Zostera banks, but from the shore the first visible sign of plant colonization is a faint greenish tinge, which can be easily perceived on the mud-banks exposed at low tide, and which is found to be due to the occupation of the banks by scattered plants of *Salicornia herbacea*, and green algæ like Enteromorphas. The top of these mud-banks may be readily colonized by a fairly dense population of *Salicornia*, which will, especially when assisted by a layer of gelatinous and coherent algæ, finally fix the banks. Should this *Salicornia* settlement connect with the shore, it will be invaded by the trailing runners of the grass *Glyceria maritima*, and the whole combination then forms an efficient sieve to retain all flotsam and silt. Then follow the beautiful silvery pink sheets of Armeria, and the associated plants like Triglochin, *Plantago maritima*, and *Aster Tripolium*. The Armeria flats, which are numerous in the Solway, afford valuable pasture for cattle and sheep, whose manure greatly improves the soil; and by the time they are firmly consolidated and above ordinary high tides, the Armeria plants become suppressed by rushes, sedges, grasses, and clovers, the land also becoming embanked and enclosed. The acquisition of new land by the Solway plants seem to be hindered by numerous irregular rivulets of fresh water, which greatly interfere with the growth of the Armeria flats.

OBITUARY.

H.M. King Leopold of Belgium.

By the death of H.M. Leopold II., King of the Belgians, the Society loses one of the small company of its honorary members. King Leopold was elected an honorary member in May, 1865, shortly before his accession to the throne. As Duke of Brabant he had displayed considerable love of travel, and carried out more than one extended tour in the Near and Far East. There is reason to believe

that at this time he had thoughts of seeking to establish a Belgian colony in the Eastern Archipelago. His accession to the throne at the end of 1865, at the age of thirty years, gave him other things to think of; but in the middle seventies, when the journeys of Livingstone and Stanley had aroused the interest of the civilized world in the opening up of Central Africa to a pitch of unparalleled enthusiasm, King Leopold took the lead in organizing what at first assumed the character of an international campaign for the exploration of the Dark Continent. In 1876 there was held at Brussels, on his invitation, an international conference, attended by, among others, Sir Bartle Frere, Sir Henry Rawlinson, Sir (then Mr.) William Mackinnon, Commander Cameron, Baron von Richthofen, Dr. Nachtigal, Dr. Schweinfurth, Herr Rohlfs, M. d'Abbadie, and M. Henri Duveyrier. The result was the formation of the International African Association, founded for the exploration and civilization of Central Africa. The delegates to the conference were not representative of their Governments, and the Association soon lost its international character. National committees were to have been appointed, and in some countries were appointed, to work in conjunction with the Association; but in England the Council of the Royal Geographical Society, which was invited to form the British committee, felt unable to take part in an enterprise of which the developments could not be foreseen, and instead the Royal Geographical Society started its African Exploration Fund for the despatch of independent British expeditions to Africa. The International Association sent out one or two expeditions, which were mainly Belgian in character, for the exploration of the interior from the east coast, but without much result. The return of Stanley in 1877, after his great journey across the continent, in which he descended the Congo river, gave a new turn to King Leopold's African ambitions. A Comité des Études du Haut Congo, the forerunner of the International Association of the Congo, was formed, and in 1879 an expedition was despatched under Stanley, who, after some preliminary work on the east coast, entered the mouth of the Congo, and proceeded upstream, establishing stations and entering into treaties with the native chiefs. From these beginnings, which marked the commencement of the modern partition of Africa, sprang the Congo Free State with King Leopold as independent sovereign. Into the subsequent history of the Congo Free State, until its annexation by Belgium as a Belgian colony in the autumn of 1908, this is not the place to enter. One result of King Leopold's death is the reversion to the Anglo-Egyptian Sudan of the Lado Enclave, the strip of territory along the left bank of the upper Nile north of Lake Albert, which was held on lease by King Leopold under agreements with the British Government of May, 1894, and May, 1906.

Colonel George Earl Church.

We regret to announce the death of Colonel George Earl Church, one of the foremost authorities on the history and geography of South America, and for some years a member of the Council and Vice-President of the Royal Geographical Society. Colonel Church was born on December 7, 1835, at New Bedford, Massachusetts, and to the end of his life remained a citizen of the United States. He was the first and only Fellow of the Society not a British subject to be elected a member of the Council. On his father's side, he was directly descended from Richard Church, who settled in Massachusetts in 1632, and on his mother's side not only traced his descent from a daughter of Edward Winslow, who sailed in the *Mayflower* and was three times governor of the New Plymouth Colony, but was connected with the Pease family of Yorkshire. He was educated as a civil engineer, and, after being engaged on various public works, including the Hoosac tunnel,

obtained an appointment under the Argentine Government in 1858 as a member of a scientific commission for the exploration of the south-western frontier of Argentina. The commission, which covered a distance of 7000 miles in nine months, had many exciting adventures with the Indians, and on one occasion it was reported in Buenos Aires that Mr. Church had been captured and burned to death. Afterwards he was engaged first in the survey and then in the construction of the Great Northern railway of Buenos Aires, until, on the outbreak of the Civil War in the United States, he left the Argentine Republic to serve as a volunteer under the Federal Government. During the war he rose to the rank of colonel, and after its close was appointed special war correspondent of the *New York Herald* to visit Mexico, then in the throes of revolution against the Emperor Maximilian. Colonel Church has already published 'A Historical Review of Mexico and its Revolutions.' On his new mission, which had been arranged with the approval of the United States Government, he attached himself to the army of President Juarez, and shared the fortunes of the republican forces till the capture of Maximilian in 1867, experiencing many adventures, in some of which he barely escaped with his life.

After serving for a short while on the editorial staff of the *New York Herald*, Colonel Church was invited, on behalf of the Bolivian Government, to engage in the task of opening up Bolivia to trade by way of the river Amazon and its tributaries. Having once undertaken this task, Colonel Church threw himself into its accomplishment with characteristic energy, making frequent visits to Bolivia and the adjacent republics, and traversing long stretches of the remote interior. He obtained from Brazil a concession to construct a railway to avoid the falls of the Madeira river, and succeeded in enlisting considerable support for the project in this country. But the concession and the companies which were formed in connection with it became the subject of protracted legal proceedings, and eventually the enterprise had to be abandoned. For more than ten years Colonel Church's energies had been devoted to these attempts to promote the development of Bolivia's resources from the side of Brazil, and his acquaintance with South America was remarkably varied and extended. In 1880 he was appointed United States Commissioner to report on the affairs of Ecuador, and at the same time was entrusted by the English bondholders with the task of readjusting the foreign debt of that country. Making his headquarters at Quito, he carried out some interesting journeys in the direction of the Colombian frontier.

On the completion of this mission, Colonel Church took up his residence in London, which remained his home down to the time of his death. He was connected with various important railway undertakings both in North and South America, which continued to take him abroad from time to time. But he also devoted much time and attention to the affairs of the Royal Geographical Society and kindred scientific bodies. He had joined the Society in 1872, and was elected to the Council in 1898, holding office till 1901. In 1902 he was elected a Vice-President of the Society, and served in that capacity for five years, afterwards remaining a member of the Council till May, 1909. Colonel Church was a frequent contributor to the *Journal*, among his more important contributions being papers on "South America: An Outline of its Physical Geography" (vol. **17**, p. 333); "Inter-Oceanic Communication on the Western Continent" (vol. **19**, p. 313); and "The Acre Territory and the Caoutchouc Region of South-West Amazonia" (vol. **23**, p. 596). The first-named paper was read in abstract at an evening meeting of the Society on February 25, 1901, and was intended to be the preliminary chapter of a great work on South America, which unhappily was never completed. In 1898 Colonel Church was President of the Geographical Section of the British Association at its Bristol meeting, and took as the subject of his presidential

address, "Argentine Geography and the Ancient Pampean Sea." The address, which was both illuminating and suggestive, and revealed a wide range of knowledge, was afterwards reprinted in the *Journal* (vol. **12**, p. 386). Colonel Church's interest in the history of travel, as well as in modern enterprise, was shown by his presence on the Council of the Hakluyt Society. He was also a Fellow of the Royal Historical Society, and a member of the Royal Anthropological Institute. His death, after a long and painful illness, occurred on January 4.

Prof. Henry Hillyer Giglioli.

The death occurred at Florence on December 16 of Prof. Henry Hillyer Giglioli, Director of the Royal Museum of Natural History in that city, and an honorary corresponding member of the Royal Geographical Society. The son of a political refugee from Italy, who took up his residence in Edinburgh and there married a Scottish lady, Henry Giglioli was born in 1843. In later years his father returned to Italy, taking his family with him, but at the age of seventeen young Enrico was sent back to London by the Italian Government to study zoology, and at Huxley's lectures and the meetings of the Zoological Society he became acquainted with most of the leading English naturalists, with some of whom he maintained a life-long friendship. On his return to Italy, he was appointed assistant naturalist on the *Magenta*, a vessel of the Italian navy, commissioned by the Italian Government for a voyage of scientific exploration. Returning from this voyage, the young naturalist was appointed Professor of Zoology at Florence with charge of the Royal Natural History Museum. From then until the time of his death his reputation grew, until he came to be recognized as one of the leading zoologists in Europe. In particular he was an expert ornithologist. He was also much interested in ethnology, and formed a valuable private ethnological collection. From time to time he engaged in research expeditions, especially for the study of the Mediterranean sea and the Italian lakes. As the representative of the Italian Government and Italian scientific societies, he attended a large number of international congresses in various parts of the world. He was elected an honorary corresponding member of the Royal Geographical Society in 1876.

Lieut.-Colonel A. E. G. Watherston, C.M.G.

By the death of Colonel Watherston the Society loses an able and accomplished Fellow, and the public service a singularly competent officer. Colonel Watherston obtained a commission in the Royal Engineers in February, 1887, and after spending some years on regimental duty was appointed an instructor in surveying at the School of Military Engineering. In 1898 he was made assistant commissioner on the Anglo-Portuguese Boundary Commission in South-East Africa. He was next appointed British commissioner for the delimitation of part of the boundary between French territory and the Gold Coast. In July, 1901, he was given the post of Director of Surveys of the Gold Coast, and for the next four years the work of mapping the colony, especially in the matter of defining the concessions of the various gold-mining companies, showed his great business capacity. During this period, also, he carried out the duty of Chief Boundary Commissioner for the Gold Coast-Ivory Coast frontier.

In April, 1905, he was appointed Chief Commissioner of the Northern Territories of the Gold Coast. He threw himself heart and soul into the work of governing this great block of country, and was an ideal chief commissioner. He did not,

however, escape the penalty of a long residence in a newly administered, remote, and unhealthy region. He suffered several times from black-water fever, but with characteristic pluck he kept to his work.

The Empire owes much to pioneer explorers and administrators of Colonel Watherston's type. Too often, it is to be feared, officials at home treat the risks incurred by such men as a matter of course. Too often men of courageous and self-reliant temper, who have incurred such risks, and have suffered from tropical illnesses, overestimate their powers of resistance.

To the grief of all those Fellows of our Society who knew him, Colonel Watherston died of fever at Tamale, in the Northern Territories of the Gold Coast, on December 12, 1909. C. F. C.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1908–1909.

RESEARCH DEPARTMENT.

December 16, 1909.—Dr. A. Strahan in the Chair.

"Changes in the Channel of the Trent." By Bernard Smith.

"Glaciation in New Zealand." By A. E. Kitson and E. O. Thiele.

Christmas Lecture, Monday, January 3, 1910.—"Travels in Bird-Land." By Richard Kearton.

Christmas Lecture, Friday, January 7, 1910.—"Across the High Carpathians." By the Rev. T. T. Norgate.

Sixth Meeting, January 10, 1910.—Major Leonard Darwin, President, in the Chair.

Elections.—*Harry Spencer Scott Harden*; *Frank C. Laurie*; *Frederick L. Monsen*; *Erik Forsten Mysström*; *Arthur Thomas Purves*; *A. G. Stigand*; *Henry Coghlan White*; *William Young*.

Colonel G. E. Church.

The President said: Before proceeding to the business of the evening, I must ask your permission to allude to a great loss which the Society has sustained in the death of Colonel Church. He must have been known, I think, to everybody here present, as he so often took part in our meetings, discussing most frequently questions connected with South America. As you will have seen from the obituary notice in the papers, his life was a very eventful one, an exceedingly interesting one, and never an idle one. It is, however, rather as a colleague that I would speak of him to-night, than of his public career. In his death we have lost one who served as Vice-President on the Council for many years, and was always a wise councillor and a sincere friend.

The paper read was:—

"Travels of a Naturalist in South-West Africa." By Prof. H. H. W. Pearson.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Austria—Bosnia and Herzegovina. **Holbach.**

Bosnia and Herzegovina: some wayside wanderings. By Maude M. Holbach. London: J. Lane, 1910 [1909]. Size 7½ × 5, pp. 250. *Map and Illustrations. Price 5s. net. Presented by the Publisher.*

Balkan Peninsula—Karst. **Katzer.**

Karst und Karsthydrographie. Von D. Friedrich Katzer. ('Zur Kunde der Balkan-halbinsel,' herausgegeben von Dr. Carl Patsch, Heft 8.) Sarajevo: D. A. Kajon, 1909. Size 9 × 6, pp. iv. and 94. *Sketch-map, Sections, and Illustrations. Price 2.50m.*

Germany. **Colquhoun.**

1912? Germany and sea power. By Archibald R. Colquhoun. London: Sir I. Pitman & Sons, 1909. Size 7 × 5, pp. vi. and 120. *Sketch-maps. Price 1s. net. Presented.*

Germany—Brandenburg. **Friedel and Mielke.**

Landeskunde der Provinz Brandenburg. . . . herausgegeben von Ernst Friedel und Robert Mielke. Band I.—Die Natur. Von D. G. Schwalbe, Prof. Dr. E. Zache, Dr. P. Graebner und Prof. Dr. Karl Eckstein. Berlin: D. Reimer, 1909. Size 11 × 7½, pp. xvi. and 430. *Maps and Illustrations. Price 5s.*

Italy. **King and Okey.**

Italy to-day. By Bolton King and Thomas Okey. New edition. London: J. Nisbet & Co., 1909. Size 8½ × 5½, pp. xii. and 414. *Price 6s. net. Presented by the Publishers.*

Italy—Lakes. **Grieben.**

The Lakes of Northern Italy and Milan: a practical guide. (Grieben's Guide Books, vol. 124.) London: Williams & Norgate, 1909–10 [1909]. Size 6 × 4, pp. 154. *Maps and Plan. Price 3s. net. Presented by the Publishers.*

Italy—Vesuvius. **Stübel.**

Der Vesuv. Eine vulkanologische Studie für Jedermann. Von Alphons Stübel, . . . herausgegeben von W. Bergt. (Veröffentlichungen des städtischen Museums für Länderkunde zu Leipzig.) Leipzig: M. Weg, 1909. Size 31½ × 10½, pp. iv. and 26. *Maps and Illustrations. Presented by Dr. W. Bergt (Director, Museum für Länderkunde, Leipzig).*

Switzerland—Valais. **Desbuissons.**

La vallée de Binn (Valais). Etude géographique, géologique, minéralogique et pittoresque. Par Léon Desbuissons. Lausanne: G. Bridel & Cie., 1909. Size 9½ × 6½, pp. viii. and 328. *Map, Illustrations, and Sections. Price* 10 *fr. Presented by the Author.*

Turkey—Albania. **Durham.**

High Albania. By M. Edith Durham. London: E. Arnold, 1909. Size 9 × 6, pp. xii. and 352. *Map and Illustrations. Price* 14*s. net. Presented by the Publisher.*

United Kingdom. **Buxton.**

By road and river: A descriptive geography of the British Isles. By E. M. Wilmot Buxton. London: Methuen & Co., [1909]. Size 7½ × 5, pp. viii. and 154. *Maps and Illustrations. Price* 2*s. Presented by the Publishers.*

United Kingdom. **Herbertson.**

The Oxford Geographies. Edited by A. J. Herbertson. The elementary geography: Vol. 2. In and about our own islands. By F. D. Herbertson. Oxford: Clarendon Press, 1909. Size 7½ × 5, pp. 112. *Maps and Illustrations. Price* 1*s. Presented by the Publishers.*

United Kingdom—Gloucestershire. **Evans.**

Cambridge County Geographies (edited by F. H. H. Guillemard). Gloucestershire. By Herbert A. Evans. Cambridge: University Press, 1909. Size 7½ × 5, pp. x. and 156. *Maps and Illustrations. Price* 1*s.* 6*d. Presented by the Publishers.*

United Kingdom—Kent. **Whitaker and others.**

Memoirs of the Geological Survey: England and Wales. The Water-supply of Kent, with records of sinkings and borings. By William Whitaker. With contributions by H. Franklin Parsons, Hugh Robert Mill, and J. C. Thresh. London, 1908. Size 10 × 6, pp. vi. and 400. *Map. Price* 8*s.* 6*d. Presented by the Geological Survey.*

Dr. Mill's note on the rainfall was referred to in the *Journal* for May last (p. 594).

United Kingdom—Middlesex. **Jerrold.**

Highways and Byways in Middlesex. By Walter Jerrold. London: Macmillan & Co., 1909. Size 8 × 5, pp. xviii. and 400. *Illustrations. Price* 6*s. Presented by the Publishers.*

United Kingdom—Midlands. **Fox-Strangways.**

Memoirs of the Geological Survey: England and Wales. The Geology of the Leicestershire and South Derbyshire coalfield. By C. Fox-Strangways. London, 1907. Size 10 × 6, pp. vi. and 374. *Map, Plans, and Sections. Price* 6*s. Presented by the Geological Survey.*

United Kingdom—Scotland. *P.R.I.* **18** (1909): 657–676. **Chrystal.**

Seiches in the Lakes of Scotland. Py Prof. George Chrystal. *Illustrations and Diagrams.*

United Kingdom—Scotland—Lakes. **Chrystal.**

An Investigation of the Seiches of Loch Earn by the Scottish Lake Survey. Part III. Observations to determine the Periods and Nodes. Part IV. Effect of Meteorological Conditions upon the Denivellation of Lakes. Part V. Mathematical Appendix on the Effect of Pressure Disturbances upon the Seiches in a Symmetric Parabolic Lake. By Prof. Chrystal. (From the *Transactions of the Royal Society of Edinburgh*, vol. **46**, pt. iii., 1908.) Edinburgh, 1908. Size 12 × 9½, pp. 455–517. *Diagrams.*

Noticed in the November number.

United Kingdom—South Wales. *Quart. J. Geol. S.* **65** (1909): 281–350. **Davis.**

Glacial Erosion in North Wales. By Prof. William Morris Davis. *Sketch-map and Diagrams.*

See note in the number for July, 1909, p. 83.

United Kingdom—Staffordshire. **Gibson.**

Memoirs of the Geological Survey: England and Wales. The geology of the North Staffordshire coalfields. By Walcot Gibson. London, 1905. Size 10 × 6, pp. viii. and 524. *Maps, Illustrations, and Sections. Price* 6*s. Presented by the Geological Survey.*

United Kingdom—Tipperary. **Hill and others.**

P.R. Irish A. **27** (1909): Sect. B, 235-268.

The Mitchelstown caves, co. Tipperary. By Charles A. Hill, Harold Brodrick, and Alexander Rule. *Plans and Illustrations.*

Summarized in the Monthly Record, December, 1909, p. 676.

United Kingdom—Wiltshire. **Bradley.**

Cambridge County Geographies (edited by F. H. H. Guillemard). Wiltshire. By A. G. Bradley. Cambridge: University Press, 1909. Size 7½ × 5, pp. xii. and 156. *Maps, Illustrations, and Diagrams. Price* 1*s.* 6*d. Presented by the Publishers.*

ASIA.

Asia—Text-book. **Herbertson.**

The Oxford Geographies. Edited by A. J. Herbertson. The Elementary geography. Vol. 4, Asia. By F. D. Herbertson. Oxford: Clarendon Press, 1909. Size 7½ × 5, pp. 128. *Maps and Illustrations. Price* 1*s.* 6*d. net. Presented by the Publishers.*

Ceylon. **Parker.**

Ancient Ceylon: an account of the aborigines and of part of the early civilisation. By H. Parker. London: Luzac & Co., 1909. Size 10 × 6, pp. xiv. and 696. *Sketch-maps and Illustrations. Price* 25*s. net. Presented by the Publishers.*

China. **Kemp.**

The face of China: travels in East, North, Central, and Western China; with some account of the new schools, universities, missions, and the old religious sacred places of Confucianism, Buddhism, and Taoism. The whole written and illustrated by E. G. Kemp. London: Chatto & Windus, 1909. Size 9½ × 6½, pp. xvi. and 276. *Map and Illustrations. Price* 20*s. net. Presented by the Publishers.*

China. **Liddell.**

China: its marvel and mystery. By T. Hodgson Liddell, R.B.A. London: G. Allen & Sons, 1909. Size 10 × 7½, pp. xiv. and 204. *Illustrations. Price* 21*s. net. Presented by the Publishers.*

China—Historical. **Eames.**

The English in China: being an account of the intercourse and relations between England and China from the year 1600 to the year 1843 and a summary of later developments. By James Bromley Eames. London: Sir I. Pitman & Sons, 1909. Size 8½ × 5½, pp. xii. and 622. *Map, Plan, and Illustrations. Price* 20*s. net.*

Chinese Turkestan—Archæology. **Pelliot.**

La mission Pelliot en Asie centrale. (*Annales de la Société de Géographie Commerciale*, Section Indo-chinoise, Fasc. 4.) Hanoi, 1909. Size 11 × 7½, pp. viii. and 48. *Map. Presented by M. Paul Pelliot.*

Eastern Asia. **Austin.**

A scamper through the Far East, including a visit to Manchurian battlefields. By Major Herbert H. Austin. London: E. Arnold, 1909. Size 9 × 5½, pp. xvi. and 336. *Maps and Illustrations. Price* 15*s. net. Presented by the Publisher.*

India. **Cox.**

My thirty years in India. By Sir Edmund C. Cox. London: 1909. Molls & Boon. Size 9 × 5½, pp. xii. and 306. *Illustrations. Price* 8*s. net. Presented by the Publishers.*

India. **Curzon.**

The place of India in the Empire; being an address delivered before the Philosophical Institute of Edinburgh by Lord Curzon of Kedleston. London: J. Murray, 1909. Size 8½ × 5½, pp. 46. *Price* 1*s. Presented by the Publisher.*

India—Burma. **Sturdza.**

En Birmanie: souvenirs de chasse et de voyage. Par le Prince Grégoire Sturdza. Paris: Libr. Plon, 1909. Size 10 × 7, pp. 236. *Map and Illustrations. Presented by the Author.*

India—Eastern Bengal and Assam. **Cooch Behar.**

Thirty-seven years of big-game shooting in Cooch Behar, the Duars, and Assam. A rough diary by the Maharajah of Cooch Behar. London: R. Ward, Ltd., 1908. Size 9½ × 7½, pp. xxviii. and 462. *Map and Illustrations. Price* 21*s. net. Presented by the Publisher.*

India—Himalaya. **Workman.**

Peaks and glaciers of Nun Kun: a record of pioneer exploration and mountaineering in the Punjab Himalaya. By Fanny Bullock Workman and William Hunter Workman. London: Constable & Co., 1909. Size 9½ × 6½, pp. xvi. and 204. *Map and Illustrations. Price* 18*s. net. Presented by the Publishers.*

India—Sikkim and Bhutan. **White.**

Sikhim and Bhutan, twenty-one years on the North-East frontier, 1887–1908. By J. Claude White. London: E. Arnold, 1909. Size 10½ × 7, pp. xx. and 332. *Map and Illustrations. Price* 21*s. net. Presented by the Publisher.*

See review, *ante*, p. 182.

India and Ceylon. **Murray.**

A handbook for travellers in India, Burma, and Ceylon. . . . Seventh edition. London: John Murray, 1909. Size 7 × 4½, pp. cxvi. and 528. *Maps, plans, and Illustrations. Price* 20*s. Presented by the Publishers.*

Mainly a reprint of the fifth edition (itself thoroughly revised), but brought up to date, and with some additional matter.

Malaya. **Wolff.**

Im malaiischen Urwald und Zinngebirge. Von Dr. Wilhelm Wolff. Berlin: A. Schall, [1909]. Size 9½ × 6½, pp. x. and 240. *Illustrations. Price* 5*m.*

Describes the author's travels in Sumatra and in Siamese and British Malaya.

Russia—Siberia. *Le tour du Monde* **15** (1909): 313–384. **Labbé.**

Avec les Lamas de Sibérie. Par Paul Labbé. *Sketch-map and Illustrations.*

Russia—Siberia—Ethnology. **Bogoras.**

The Jesup North Pacific Expedition. Vol. 7. The Chukchee. By Waldemar Bogoras. Leyden and New York, 1904–09. Size 14 × 11, pp. xviii. and 734. *Sketch-map and Illustrations. Price* 37 *fl.* 50.

Russian Central Asia. *National G. Mag.* **20** (1909): 749–760. **Huntington.**

Life in the Great Desert of Central Asia. By Ellsworth Huntington. *Illustrations.*

Russian Central Asia. *Annuaire géol. et min. Russie* **12** (1910): 19–26. **Ivchenko.**

Schluchten auf dem Plateau Ischokusu. Von Alexander Iwtschenko. *Illustrations and Sections.* [In Russian and German.]

Turkey—Asia Minor. **Townshend.**

A military consul in Turkey: the experiences and impressions of a British representative in Asia Minor. By Captain A. F. Townshend. London: Seeley & Co., 1910 [1909]. Size 9 × 5½, pp. 328. *Illustrations. Price* 16*s. net. Presented by the Publishers.*

Western Asia. **Benn.**

An overland trek from India by side-saddle, camel, and rail: the record of a journey from Baluchistan to Europe. By Edith Fraser Benn. London: Longmans, Green & Co., 1909. Size 9 × 6, pp. xvi. and 344. *Map and Illustrations. Price* 15*s. net. Presented by the Publishers.*

AFRICA.

Belgian Congo—Administration. **Morel.**

Great Britain and the Congo: the pillage of the Congo basin. By E. D. Morel. London: Smith, Elder & Co., 1909. Size 8 × 5, pp. xxvi. and 292. *Maps. Price* 6*s. net. Presented by the Publishers.*

East Africa—Forestry. **Hutchins.**

East Africa Protectorate. Report on the Forests of British East Africa. By D. E. Hutchins. London: Wyman & Sons, 1909. Size 13 × 8½, pp. 144. *Maps and Illustrations. Price* 2*s.* 5*d.*

Egyptian Sudan—"Sudd." **Deuerling.**

Die Pflanzenbarren der afrikanischen Flüsse, mit Berücksichtigung der wichtigsten pflanzlichen Verlandungserscheinungen. Von Dr. Oswald Deuerling. (*Münchener G. Studien* (*Günther*) **24** (1910): pp. 254.) *Map and Illustrations.*

See review in the present number, p. 184.

German East Africa—Ethnology. **Weule.**

Native life in East Africa: the results of an ethnological research expedition. By Dr. Karl Weule. London: Sir I. Pitman & Sons, 1909. Size 9 × 6, pp. xxiv. and 432. *Map and Illustrations. Price* 12*s.* 6*d. net.*

Morocco. **Harris.**

With Mulai Hafid at Fez: behind the scenes in Morocco. By Lawrence Harris. London: Smith, Elder & Co., 1909. Size 8 × 5, pp. xvi. and 270. *Illustrations. Price 7s. 6d. net. Presented by the Publishers.*

North Africa—Historical. **Piquet.**

Victor Piquet. Les civilisations de l'Afrique du Nord: Berbères, Arabes, Turcs. Paris: A. Colin, 1909. Size 7½ × 5, pp. x. and 396. *Sketch-maps. Price 4 fr. Presented by the Publisher.*

Rhodesia. **Hone.**

Southern Rhodesia. By Percy F. Hone. London: G. Bell & Sons, 1909. Size 9 × 5½, pp. xvi. and 406. *Maps and Illustrations. Price 10s. 6d. net. Presented by the Publishers.*

South Africa. **Cana.**

South Africa from the Great Trek to the Union. By Frank R. Cana. London: Chapman & Hall, 1909. Size 9 × 6, pp. x. and 340. *Maps. Price 10s. 6d. net. Presented by the Publishers.*

South Africa—Administration. **Brand.**

The union of South Africa. By the Hon. R. H. Brand. Oxford: Clarendon Press, 1909. Size 9 × 5½, pp. 192. *Price 6s. net. Presented by the Publishers.*

South Africa—Ethnography. **Anderson and Stanley.**

T. Geol. S. South Africa **12** (1909): 54–66.

Some remarks on the intimate relations between archæology and geology in South Africa; with a description of caves containing human and other mammalian remains on the farms Wonderfontein and Rooipoort, Potchefstroom district. By William Anderson and Prof. G. H. Stanley. *Plans.*

South Africa—Minerals. **Johnson.**

The ore deposits of South Africa. By J. P. Johnson. Part II. London: Crosby, Lockwood & Son, 1909. Size 8½ × 5½, pp. vi. and 52. *Sketch-map and Sections. Price 5s. net. Presented by the Publishers.*

South Africa—Phytogeography. **Marloth.**

Das Kapland, insonderheit das Reich der Kapflora, das Waldgebiet und die Karroos, pflanzengeographisch dargestellt von Dr. Rudolf Marloth. (*W. Ergebnisse "Valdivia"-Expedition*, 1898–99 (*Chun*) **2** (1908): 3 Teil, pp. 436.) *Maps and Illustrations.*

West Africa. **Simpson.**

West Africa. Report by Prof. W. J. Simpson on Sanitary Matters in various West African Colonies and the Outbreak of Plague in the Gold Coast. London: Wyman & Sons, 1909. Size 13 × 8½, pp. 130. *Maps, Plans, and Illustrations. Price 9d.*

West Africa—Historical. **Avelot.**

L'Afrique Occidentale au Temps des Antonins. Par le Capitaine R. Avelot. (Extrait du *Bulletin de Géographie historique et descriptive*, No 1–2, 1908.) Paris, 1909. Size 10 × 6½, pp. 48. *Sketch-maps. Presented by the Author.*

A discussion of Ptolemy's Geography of West Africa (see p. 79 of this volume).

Tripoli. **Furlong.**

The gateway to the Sahara: observations and experiences in Tripoli. By Charles Wellington Furlong. London: Chapman & Hall, 1909. Size 8½ × 5½, pp. xxvi. and 306. *Sketch-maps and Illustrations. Price 12s. 6d. net. Presented by the Publishers.*

Zambezi—Victoria Falls. *Quart. J. Geol. S.* **65** (1909): 390–407. **Codrington.**

Some Notes on the Neighbourhood of the Victoria Falls (Rhodesia). By Thomas Codrington. *Sketch-map, Section, and Illustration.*

Zanzibar. ———

Africa. No. 4 (1909). Despatch from His Majesty's Agent and Consul-General at Zanzibar, furnishing a Report on the Administration, Financial, and General condition of the Zanzibar Protectorate. London: Wyman & Sons, 1909. Size 13 × 8½, pp. 54.

NORTH AMERICA.

Labrador. **Robinson.**

In an unknown land: a journey through the wastes of Labrador in search of gold. By Edward Colpitts Robinson. London: E. Stock, 1909. Size 7½ × 5, pp. xii. and 154. *Illustrations. Price 3s. net. Presented by the Publisher.*

Mexico—Yucatan. **Arnold and Frost.**

The American Egypt: a record of travel in Yucatan. By Channing Arnold and Frederick J. Tabor Frost. London: Hutchinson & Co., 1909. Size 9½ × 6, pp. xiv. and 392. *Map, Plans, and Illustrations. Price 16s. net.*

See review, *ante*, p. 189.

North America—Birds. **Chapman.**

Camps and cruises of an ornithologist. By Frank H. Chapman. London: Hodder & Stoughton, [1909]. Size 9 × 6, pp. xvi. and 432. *Illustrations and Sketch-map. Price 12s. net.*

United States. [*U.S.*] *Bureau of Census, B.* **101** (1909): pp. 82. ——

Industrial Districts: 1905. Manufactures and Population. *Sketch-maps.*

United States—California. **Lawson and others.**

The California Earthquake of April 18, 1906. Report of the State Earthquake Investigation Commission. By Andrew C. Lawson. Vol. 1. Washington: Carnegie Institution, 1908. Size 11½ × 9, pp. xvii. and 452. *Maps, Illustrations, and Sections; also separate Atlas* (size 24 × 19). *Price* $17. *Purchased.*

United States—Colorado Desert. *National G. Mag.* **20** (1909): 681–701. **Mendenhall.**

The Colorado Desert. By W. C. Mendenhall. *Illustrations.*

United States—Hudson River. **Johnson.**

The picturesque Hudson. By Clifton Johnson. London: Macmillan & Co., 1909. Size 7 × 4½, pp. xiv. and 228. *Illustrations. Price 5s. net. Presented by the Publishers.*

United States—Illinois. ——

Chemical and Biological Survey of the waters of Illinois. Report from September 1, 1906, to December 31, 1907. Edward Bartow, Director. (From the *University of Illinois Bulletin*, vol. 6, No. 4, 1908.) Urbana, 1908. Size 9 × 6, pp. 88. *Illustrations and Diagrams.*

United States—New York. **Rensselaer.**

History of the city of New York in the seventeenth century. By Mrs. Schuyler van Rensselaer. 2 vols. New York: The Macmillan Co., 1909. Size 9 × 6, pp. (vol 1) xxviii. and 534; (vol. 2) xii. and 640. *Facsimile Map and Plan. Price 24s. net.*

United States—New York. **Rensselaer.**

New York State Library. Van Rensselaer Bowier Manuscripts; being the letters of Kiliaen van Rensselaer, 1630–1643, and other documents relating to the colony of Rensselaerswyck. Translated and edited by A. J. F. van Laer. (Ninetieth Annual Report on the New York State Library, vol. 2.) Albany, 1908. Size 2 × 5½, pp. 910. *Facsimile map and Illustrations.*

Refers to Dutch settlements in the neighbourhood of Albany.

United States—North-West. *National G. Mag.* **20** (1909): 645–663. **Darton.**

Our Pacific North-west. By W. H. Darton. *Illustrations.*

CENTRAL AND SOUTHERN AMERICA.

Bolivia and Peru—Boundary. **Ballivian.**

El laudo argentino: inaceptable para Bolivia, inconveniente para el Perú. Por Adolfo Ballivian. La Paz, 1909. Size 10½ × 7, pp. 110. *Maps. Presented by the Author.*

Brazil. **Vallentin.**

In Brasilien. Von Dr. W. Vallentin. Berlin: H. Paetel, 1909. Size 9½ × 6½, pp. viii. and 256. *Illustrations. Price 4s.*

Travels in various parts of Brazil, with a view to studying the economic conditions, etc.

Brazil—Amazon. **Highams.**

Across a continent in a man-of-war; being the Log of Commission of H.M.S. *Pelorus*, 1906–1909. With a full account of her cruise of 2000 miles up the Amazon. By E. E. Highams. London: Westminster Press, 1909. Size 7½ × 5, pp. xvi. and 240. *Illustrations. Price 5s. net.*

Colombia and Panama. **Cortes and Arosemena.**

B. Minis. Relac. Exteriores Columbia **2** (1909): 426–432.

Tratado entre las Repúblicas de Columbia y de Panamá. Par Enrique Cortes et C. C. Arosemena.

This is referred to in the Monthly Record for November, 1909.

Guatemala—Earthquake. **Ascoli.**

Mem. Manchester Philos. S. **53** (1908–09): No. 23, pp. 8.

The Guatemala Earthquake and Eruption of 1902. By W. S. Ascoli. *Illustrations.*

Panama and Ecuador. **Festa.**

Dr. E. Festa. Nel Darien e nell' Ecuador: diario di viaggio di un naturalista. Turin: Union Tip.-Editrice, 1909. Size 10 × 7, pp. xvi. and 398. *Maps and Illustrations. Price 10 lire. Presented by the Author.*

Peru. *Appalachia* **12** (1909): 34–45. **Douglass.**

The Crescentic Dunes of Peru. By A. E. Douglass. *Diagram and Illustrations.*

Peru. **Wright.**

The old and the new Peru: a story of the ancient inheritance and the modern growth and enterprise of a great nation. By Marie Robinson Wright. Philadelphia (London: C. S. Cazenove & Son), [1908]. Size 12½ × 10, pp. 456. *Map and Illustrations. Presented by Señor E. Lembcke, Peruvian Chargé d'Affaires.*

Salvador and Costa Rica. **Peña.**

Viajes par la Costa del Pacífico. De San Salvador á Costa Rica. Par José Maria S. Peña. San Salvador, 1909. Size 7 × 5, pp. 70. *Presented by the Author.*

South America—River Plate. *Scottish G. Mag.* **25** (1909): 469–481. **Christison.**

The River Plate Region forty-three years ago. By Dr. David Christison. *Illustrations.*

West Indies—Cuba. **Berchon.**

Conférence sur l'Ile de Cuba. Par Charles Berchon. Bordeaux, 1909. Size 10 × 6½, pp. 24. *Presented by the Author.*

AUSTRALASIA AND PACIFIC ISLANDS.

Dutch New Guinea. *Ts. K. Nederlandsch Aard. Genoots.* **26** (1909): 793–800. **Gooszen.**

Land en volk van Zuid Nieuw-Guinea. Naar A. J. Gooszen.

The writer commanded the recent survey party (*Journal*, vol. **34**, p. 638).

Fiji—Flora. *J. Linnean S. (Botany)* **39** (1909): 130–212. **Gibbs.**

A Contribution to the Montane Flora of Fiji (including Cryptogams), with Ecological Notes. By Lilian S. Gibbs. *Sketch-map and Illustrations.*

Noticed, *ante*, p. 199.

German New Guinea. *Deutsches Kolonialblatt* **20** (1909): 739–745. ——

Eine Fahrt auf den Kaiserin Augustafluss.

Summarized in the October number, p. 458.

German New Guinea—Admiralty Islands. ——

Deutsches Kolonialblatt **20** (1909): 895–900.

Eine Strafexpedition nach den Admiralitäts-Inseln.

New Caledonia and New Hebrides. *Le tour du Monde* **15** (1909): 193–216. **Myrica.**

De la Nouvelle-Calédonie aux Iles Hébrides. Par Pierre de Myrica. *Sketch-map and Illustrations.*

New Mecklenburg. *G.Z.* **15** (1909): 425–450. **Sapper.**

Neu-Mecklenburg. Von Karl Sapper.

New South Wales. *Records Geol. Surv. New South Wales* **8** (1909): 321–334. **Harper.**

Notes on the Physiography and Geology of the North-eastern Watershed of the Macquarie River. By L. F. Harper. *Sketch-map, Plan, and Sections.*

New Zealand—Historical. **McNab.**

Murihiku: a history of the South Island of New Zealand and the islands adjacent and lying to the South, from 1642 to 1835. By Robert McNab. Wellington and London: Whitcombe & Tombs, 1909. Size 8½ × 5½, pp. xvi. and 500. *Facsimile Charts and Illustrations. Price* 15*s. Presented by the Publishers.*

New Zealand—Western Otago. **Park.**

New Zealand Geol. Surv. B. No. 7 (1909): pp. x. and 112.

The Geology of the Queensland Subdivision, Western Otago Division. By James Park. *Maps, Plans, Sections, and Illustrations.*

Pacific Islands. **Walker.**

Wanderings among South Sea savages, and in Borneo and the Philippines. By H. Wilfrid Walker. London: Witherby & Co., 1909. Size 9 × 6, pp. xvi. and 256. *Illustrations. Price* 7*s.* 6*d. net. Presented by the Publishers.*

Papua. **Mackay.**

Across Papua. Being an account of a voyage round, and a march across, the territory of Papua, with the Royal Commission. By Colonel Kenneth Mackay. London: Witherby & Co., 1909. Size 9 × 5½, pp. xvi. and 192. *Map and Illustrations. Price* 7*s.* 6*d. net. Presented by the Publishers.*

POLAR REGIONS.

Antarctic—Enderby Land. **Zirkel and Reinisch.**

Untersuchung des vor Enderby-Land gedredschten Gesteinmateriales. Von F. Zirkel und R. Reinisch. (*W. Ergebnisse "Valdivia" Expedition*, 1898-99 (*Chun*) **10** (1905): 35-44.) *Illustrations.*

Antarctic—Glaciation. *Z. Gletscherkunde* **3** (1909): 321-334. **Nordenskjöld.**

Einige Beobachtungen über Eisformen und Vergletscherung der antarktischen Gebiete. Von Otto Nordenskjold.

Antarctic—Graham's Land. *Meteorologische Z.* **26** (1909): 337-347. **Voeikoff.**

Klima von Snow-Hill, Grahamland, nach den Beobachtungen der schwedischen Südpolarexpedition. Von A. Woeikow.

Antarctic—Shackleton Expedition. **Shackleton.**

The Heart of the Antarctic: being the story of the British Antarctic Expedition, 1907-1909. By E. H. Shackleton, C.V.O. With an introduction by Hugh Robert Mill, D.SC.; an account of the first journey to the South Magnetic Pole by Prof. T. W. Edgeworth David, F.R.S. 2 vols. London: W. Heinemann, 1909. Size 10 × 7, pp. (vol. 1) xlviii. and 372; (vol. 2) xvi. and 420. *Maps and Illustrations. Price* 36*s. net. Presented by the Publisher.*

Arctic—Expedition. *Nineteenth Century* **66** (1909): 586-597. **Harrison.**

A Plea for a British Arctic Expedition. By Alfred H. Harrison.

Arctic—Meteorology. *Met. Z.* **26** (1909): 145-164. **Alt.**

Die Doppelozillation des Barometers, insbesondere im arktischen Gebiete. Von E. Alt. *Sketch-maps and Diagrams.*

Arctic—North Pole. *Mouvement G.* **26** (1909): 421-431. ———

Le Dr. Frederic Cook au pôle Nord. *Portrait and Map.*

Polar Expeditions. *Nature* **81** (1909): 338-340. **[Reeves.]**

Polar Expeditions and Observations.

Polar Exploration. ———

Recent Polar Exploration. (From the *Edinburgh Review*, No. 430, October 1909.) London: Longmans, Green & Co., 1909. Size 8½ × 5½, pp. 473-497.

Polar Regions. **Nordenskjöld.**

Die Polarwelt und ihre Nachbarländer. Von Otto Nordenskjöld. Leipzig, etc.: B. G. Teubner, 1909. Size 9½ × 6½, pp. viii. and 220. *Illustrations and Sketch-map. Price* 8*m. Presented by the Publisher.*

Polar Regions. **Nordenskjöld.**

Die praktische Verwertung der Polarländer und die Spitzbergenfrage. Von Prof. Otto Nordenskjöld. (Sonderabdruck aus *Deutsche Revue*, April, 1909.) Stuttgart, 1909. Size 9½ × 6, pp. 10.

Spitsbergen—King Karl's Land. **Gothan.**
K. Svenska Vetenskaps-A. Handl. **42** (1909): No. 10, pp. 42.
Die fossilen Hölzer von Kong Karls Land. Von Dr. W. Gothan. *Illustrations.*

MATHEMATICAL GEOGRAPHY.

Altitudes. *Sitzb. K. Preuss. A.W. Berlin*, 1908: 492–511. **Helmert.**
Trigonometrische Höhenmessung und Refraktions-Koeffizienten in der Nähe des Meeresspiegels. Von F. R. Helmert.

Determination of position. **Schwarzschild and Birck.**
Tafeln zur astronomischen Ortsbestimmung im Luftballon bei Nacht, sowie zur leichten Bestimmung der mitteleuropäischen Zeit an jedem Orte Deutschlands . . . herausgegeben von Prof. Dr. K. Schwarzschild und Dr. O. Birck. Göttingen: Vandenhoeck & Ruprecht, 1909. Size 9½ × 8½, pp. 12. *Maps and Diagram. Price* 4*s.*

Longitudes. *M. k.k. Militärg. J.*, **28** (1908): 49–57. **Andres.**
Längenunterschiedmessungen zweiter Ordnung. Vorläufige Mitteilung von Leopold Andres. *Diagram.*
The longitude differences in question were determined by telegraph in the neighbourhood of Vienna.

Measurement of Areas. **Gray.**
The polar planimeter: how it is used, and how it operates. A simple treatise by Frank J. Gray. London: St. Bride's Press, [1909]. Size 7 × 5, pp. viii. and 58. *Diagrams. Price* 1*s. net. Presented by the Author.*

Navigation. **Williamson.**
Text-book of navigation and nautical astronomy. By Capt. A. P. W. Williamson. London, etc.: J. Griffin & Co., 1909. Size 9½ × 5½, pp. vi. and 388. *Charts and Diagrams. Price* 7*s.* 6*d. net. Presented by the Publishers.*

Surveying. **Pelkington.**
Co-ordinate geometry applied to land-surveying. By Woodford Pelkington. London: E. & F. N. Spon, 1909. Size 6½ × 4, pp. 44. *Diagrams. Price* 1*s.* 6*d. net. Presented by the Publishers.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Atmospheric Electricity. *Terrestrial Magnetism* **13** (1908): 119–128. **Dike.**
Report on the Atmospheric Electricity Observations made on the Magnetic Survey Yacht *Galilee*, 1907–08. By P. H. Dike.

Denudation. *American J. Sc.* **27** (1909): 349–368. **Leverett.**
Weathering and Erosion as Time Measures. By Frank Leverett. *Sketch-maps.*

Earth-movements. *XI. Jbericht G. Ges. Greifswald*, 1907–08 (1909): 17–37. **Braun.**
Ueber Bodenbewegungen. Von Dr. Gustav Braun. *Diagram.*

Earthquakes. *N. American Phil. S.* **48** (1909): 235–258. **Hovey.**
Earthquakes: their causes and effects. By Edmund Otis Hovey.

Geological History. *Sitz. K.A.W. Wien*, 1. Abt. 117 (1908): 513–518. **Höfer.**
Das polynesische alteozäne Festland. Von H. Höfer.

Geology. **Chamberlin and Salisbury.**
Geology: shorter course. By Thomas C. Chamberlin and Rollin D. Salisbury. London: J. Murray, 1909. Size 8 × 5, pp. xviii. and 978. *Maps, Sections, and Diagrams. Price* 21*s. net. Presented by the Publisher.*

Geology—Flints. **Carus-Wilson.**
The pitting of Flint surfaces. By Cecil Carus-Wilson. Teddington, 1909. Size 8 × 5½, pp. 9. *Illustrations. Presented by the Author.*
The writer ascribes the pitting to the freezing of the water absorbed.

Geomorphology. **Suess.**
Das Antlitz der Erde. Von Eduard Suess. III. Band, 2. Hälfte (pp. 790). Namens- und Sachregister für sämtliche Bände von Eduard Suess' Antlitz der Erde, bearbeitet von Dr. Lukas Waagen (pp. 158). Vienna: F. Tempsky (Leipzig: G. Freytag), 1909. Size 11 × 8. *Maps, Sections, and Illustrations. Price* (*Volume and Index*) 50*m. Presented by the Publisher.*

Oceanography. *B.I. Océanog. Monaco*, No. **143** (1909): pp. 4. **Marini.**

Quelques considérations sur le programme pour l'Exploration internationale de l'Océan Atlantique et de la Méditerranée. Par S. Marini.

Oceanography. **Wedderburn.**

Dr. O. Petterson's observations on deep-water oscillations. By E. M. Wedderburn. (Reprint from *Proceedings of the Royal Society of Edinburgh*, vol. **29**, Part 6.) Edinburgh, 1909. Size 10 × 7, pp. 602–606. *Sketch-map and Diagram.*

Oceanography—Drift-currents. *Ann. Hydrographie* **36** (1908): 481–484. **Ekman.**

Zur Frage von der Ablenkung der Triftströmungen. Von V. Walfrid Ekman.

Oceanography—Fauna. **Herdman.**

Our food from the waters. By Prof. W. A. Herdman. (Evening Discourse, British Association, Winnipeg, 1909.) [London, 1909.] Size 8½ × 5½, pp. 10.

Oceanography—Fauna. **Hjort.**

Conseil. Perm. Explor. de la mer. Rapports et Proc.-Verb. **x.** (1909): pp. 862.

Rapport sur les Travaux de la Commission A dans la période 1902–1907. (Rapporteur le Dr. Johan Hjort.) *Charts and Diagrams.*

Oceanography—Fauna. **Koehler.**

Résultats des Campagnes Scientifiques accomplies sur son yacht, par Albert 1er Prince Souverain de Monaco. Fasc. xxxiv. Echinodermes provenant des campagnes du yacht *Princesse-Alice* (Asteries, Ophiures, Échinides et Crinoides). Par R. Koehler. Monaco, 1909. Size 14 × 11½, pp. 318. *Plates.*

Oceanography—North Atlantic. **Hjort.**

Report on Norwegian fishery and marine investigations. Vol. **2** (2 parts). Edited by Johan Hjort. Bergen: J. Grieg, 1909. Size 10½ × 7½. *Charts, Diagrams, and Illustrations. Presented by the Scientific Laboratory of the Administration of the Norwegian Fisheries.*

Includes memoirs by various writers, the titles of which are entered separately in this list.

Oceanography—North Atlantic. **Wolfenden.**

Memoirs of the Challenger Society, No. 1. Scientific and biological researches in the North Atlantic, conducted by the author on his yachts the *Walwin* and the *Silver Belle*. By R. Norris Wolfenden. London: Rebman, Ltd., 1909. Size 11½ × 8½, pp. vi. and 234. *Map, Illustrations, and Sections. Price* 10*s.* 6*d. net. Presented by the Publishers.*

Oceanography—South-West Pacific. *Ann. Hydrographie* **36** (1908): 477–481. ——

Ozeanographische Arbeiten S.M.S. *Planet* im Bismarck-Archipel 1907, unter dem Kommando von Kapitänleutnant Kurtz. Von D. S.

Oceanography—Voyage. **Chun.**

Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899. Im Auftrage des Reichamtes des Innern herausgegeben von Carl Chun. II. Band, 1 Teil (pp. 1–406) and 3 Teil (pp. 436); and X. Band, Lfgn. 1–3 (pp. 1–76). Jena: G. Fischer, 1905–08. Size 13½ × 10. *Maps and Illustrations. Presented by the Imperial Foreign Office, Berlin.*

Oceanography—Voyage. **Lütgens.**

Vorläufiger Bericht über eine ozeanographische Forschungsreise. Von Dr. Rudolf Lütgens. (Sonderabdruck aus 'Annalen der Hydrographie und Maritimen Meteorologie,' 1909.) Berlin, 1909. Size 11 × 8, pp. 145–153. *Sketch-map, Illustration, and Diagrams.*

This voyage and its results were referred to in the January number (p. 84).

Terrestrial Magnetism. *Terrestrial Magnetism* **14** (1909): 57–66. ——

The Magnetic Survey Yacht *Carnegie* and Her Work. *Illustration, Portraits, and Plans.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography—Migrations. **Scott-Elliot.**

The Migration of Man. By Prof. G. F. Scott-Elliot. (Extracted from the *Transactions of the Dumfriesshire and Galloway Natural History and Antiquarian Society*, vol. **19**.) N.P., [1909]. Size 8½ × 5½, pp. 16. *Presented by the Author.*

Ethnology. **Haddon.**

The races of man and their distribution. By Dr. A. C. Haddon. London: Milner & Co., [1909]. Size 7½ × 5, pp. x. and 126. *Illustrations. Price 1s. net. Presented by the Publishers.*

Historical. **Speight and Nance.**

Britain's Sea-Story, B.C. 55—A.D. 1805. Being the story of British heroism in voyaging and sea-fight from Alfred's time to the Battle of Trafalgar. With an Introduction tracing the development of the structure of sailing ships from the earliest times. Edited by E. E. Speight and R. Morton Nance. (3rd edit.) London: H. Frowde and Hodder & Stoughton, 1909. Size 8 × 5½, pp. xiv. and 428. *Illustrations. Price 5s. Presented by the Publishers.*

Historical—Anson. **Cash.**

Anson's voyage round the world, 1740–1744. Selections, edited by C. G. Cash. London: A. Rivers, Ltd., 1909. Size 7 × 5, pp. xvi. and 152. *Sketch-map and Portrait. Price 1s. 3d. net. Presented by the Publishers.*

Historical—Place-names. **Graesse and Benedict.**

Orbis latinus, oder Verzeichnis der wichtigsten lateinischen Orts- und Ländernamen. Von Dr. J. G. Th. Graesse . . . 2 Auflage . . . neu bearbeitet von Friedrich Benedict. Berlin: R. C. Schmidt & Co., 1909. Size 10 × 6½, pp. vi. and 348. *Price 10m.*

A new edition, with considerable additions, of Graesse's valuable dictionary of Latin place-names, the chief attention being given to non-classical writers.

Historical Geography. *B. American G.S.* **41** (1909): 422–439. **Semple.**

The Operation of Geographic Factors in History. By Ellen Churchill Semple.

BIOGRAPHY.

Credner. *XI. Jahresber. G. Ges. Greifswald*, 1907–08 (1909): vii.–xxi. **Jaekel.**

Zum Gedächtnis Rudolf Credners. Von Prof. Dr. O. Jaekel. *Portrait.* Schriftverzeichnis von Rudolf Credner. Von Dr. H. Runge.

Darwin. *Deutsche Rundschau G.* **31** (1909): 433–443. **Ule.**

Darwin's Bedeutung in der Geographie. Von Willi Ule.

Lawes. **King.**

W. G. Lawes of Savage Island and New Guinea. By the Rev. Joseph King. London: The Religious Tract Society, 1909. Size 8½ × 5½, pp. xxvi. and 388. *Portraits, Map, and Illustrations. Price 5s. net. Presented by the Publishers.*

McCormick. **Casson.**

Cyrus Hall McCormick: his life and work. By Herbert N. Casson. Chicago: A. C. McClurg & Co., 1909. Size 8½ × 5½, pp. xii. and 264. *Portraits and Illustrations. Presented by the Author.*

The subject of this memoir was a pioneer of the industrial era in the United States.

Stanley. **Stanley.**

The autobiography of Sir Henry Morton Stanley, G.C.B. Edited by his wife, Dorothy Stanley. London: Sampson Low, Marston & Co., 1909. Size 9½ × 6, pp. xviii. and 552. *Portraits, Map, and Illustrations. Price 21s. net. Presented by the Publishers. Also copy of Edition-de-luxe, presented by Lady Stanley.*

GENERAL.

Bibliography—Ptolemy's Geography. **Stevens.**

Ptolemy's Geography: a brief account of all the printed editions down to 1730, with notes on some important variations observed in that of Ulm 1482, including the recent discovery of the earliest printed map of the world yet known on modern geographical conceptions in which some attempt was made to depart from ancient traditions. By Henry N. Stevens. 2nd edit. London: H. Stevens, Son, & Stiles, 1908. Size 9 × 6, pp. viii. and 62. *Presented by the Author.*

British Empire. **Barker.**

Great and Greater Britain. The problems of Motherland and Empire; political, naval, military, industrial, financial, social. By J. Ellis Barker. London: Smith,

Elder & Co., 1909. Size 8½ × 5½, pp. xii. and 380. *Price* 10*s.* 6*d. net*, *Presented by the Publishers.*

Education—Text-book. **Miller.**

Practical geography for secondary and supplementary schools. By James and William Miller. London: G. Bell & Sons, 1909. Size 7½ × 5, pp. viii. and 116. *Sketch-maps and Diagrams. Price* 2*s. Presented by the Publishers.*

German Colonies. **Schneider.**

Jahrbuch über die deutschen Kolonien. Herausgegeben von Dr. Karl Schneider. I. und II. Jahrgänge. Essen: G. D. Baedeker, 1908–1909. Size 9 × 6, pp. (I. Jg.) viii. and 208; (II. Jg.) viii. and 212. *Maps and Portraits. Price* 5*s. each.*

Handbook. **Scobel.**

Geographisches Handbuch. Allgemeine Erdkunde, Länderkunde und Wirtschaftsgeographie . . . Herausgegeben von A. Scobel. 5 . . . Auflage. II. Band. Bielefeld and Leipzig: Velhagen und Klasing, 1910. Size 10½ × 7, pp. xiv and 816. *Maps, Illustrations, and Diagrams. Price* 10*m. Presented by the Publishers.*

Paradox. **Palermo.**

La terra sensibile e cosciente. Di Antonio Palmermo. Milan: L. F. Cogliati, 1909. Size 10 × 6½, pp. 102. *Presented by the Author.*

OLDER WORKS ADDED TO THE LIBRARY AND MAP COLLECTION IN 1909.

Abella y Casariego, Enrique.—Descripción física, geológica y minera en bosquejo de la Isla de Panay; *and* Terremotos experimentados en la isla de Luzón durante los mezos de Marzo y Abril de 1892, especialmente desastrosos en Pangisanán, Unión y Benguet. (Publicaciónes oficiales.) *Maps, Diagrams, and Illustrations. Presented by the Bureau of Science, Manila, P.I.* *Manila*, 1890–93.

Cortes, Martin.—The Art of Navigation. Contayning a briefe description of the Spheare with the partes and Circles of the same; as also the making and use of certaine instruments. Very necessarie for all sortes of Sea-men to understand. First written by Martin Curtis [*sic*], and translated by Richard Eden. *Maps. Diagrams. and Volvelles.* Size 7 × 5½. *Presented by Sir Henry Bulwer.* *London*, 1596.

Ebel, D. J. G.—Die neuen Strassen durch den Kanton Graubündten, in dreyssig Blättern . . . dargestellt . . . von J. J. Meyer. *Map and Illustrations.* Size 8½ × 11. *Zürich*, 1825.

[From the Holzmann Library.]

Fale, Thomas.—Horologiographia: The art of dialling. Teaching an easie and perfect way to make all kinds of Dials upon any plaine plat howsoever placed. . . . *Diagrams.* Size 7 × 5½. *Presented by Sir Henry Bulwer.* *London*, 1627.

[Bound in one volume with Cortes' 'Art of Navigation,' *supra.*]

Gruner, Gottlieb Sigmund.—Die Eisgebirge des Schweizerlandes. 2 vols. *Maps and Illustrations.* Size 8 × 5. *Bern.* 1760.

[From the Holzmann Library].

[**Houtman, Cornelis**].—Eerste Schip-vaert, Gedaen van de Hollanders naer Oost-Indien met vier Scheepen, onder't Beleydt van Cornelis Houtman, Uyt Texel t'Zeyl gegaen, Anno 1595. Verhalende al't gedenck waerdighste dat haer op de Reys is voorgevallen te Water en te Lande, als oock de Conditien, Religien, Zeden en Huys-houdingen der Indiaensche Volckeren, de Vruchtbaerheydt van't Aerdtrijck, de Natuer en verscheydenheyt der Beesten en Vogelen, ende voorts de Koopmanschappen en andere Vreemdicheden der Landen en Steeden die zy gesien en bezeylt hebben. *Illustrations.* Size 7½ × 6. *Presented by Sir Henry Bulwer.* *Amsterdam*, [1598].

[From the Amberst Library].

James, Thomas.—The Strange and Dangerous Voyage of Captaine Thomas James, in his intended Discovery of the North-west Passage into the South Sea. *Map in facsimile, presented by Mr. H. N. Stevens.* Size 7½ × 5½. *London*, 1633.

[As purchased, this copy contained the map, by Ralph Hall, belonging to John Dunton's 'True Journal of the Sallee Fleet, 1636.' (See Churchill's Collection, vol. 8.)]

Le Roy, P. L.—Relation des aventures arrivées à quatre matelots russes, jettés par une tempête près de l'Isle déserte d'Ost-Spitzbergen, sur laquelle ils ont passé six ans et trois mois. . . . Size 6 × 6. *Presented by Sir Clements Markham.*
[*Paris*], 1766.

Leslie, John.—De origine, moribus, et rebus gestis Scotorum: Libri decem. E quibus septem, veterum Scotorum res in primis memorabiles contractius, reliqui vero tres, posteriorum Regum ad nostra tempora historiam, quæ hucusque desiderabatur, fusius explicant. Size 8½ × 6½. *Map.* *Rome*, 1578.

Lowndes, William Thomas.—The Bibliographer's manual of English literature. . . . New edition. 6 vols. (in 11). Size 7½ × 4½. *London*, 1857–64.

Ludolphus de Suchen [Ludolph von Sudheim].—Descriptio terræ sanctæ et itineris ejus Hierosolymitani. Size 6½ × 5. *Presented by Sir Clements Markham.*
Venice, [*c.* 1490].

[Malaspina and others].—Viaje político-científico alrededor del mundo por las corbetas Descobierta y Atrevida, al mando de los Capitanos de Navio D. Alejandro Malaspina y Don José de Bustamente y Guerra desde 1789 á 1794. Publicado. . . . por D. Pedro de Novo y Colson. *Map and Illustrations.* Size 13 × 9½.
Madrid, 1885.

Martyr, Peter.—De orbe novo, Petri Martyris Anglerii [*sic*]. . . . Decades octo, diligenti temporum observatione, et utilissimis annotationibus illustræ, suóque nitori restitutæ, Labore et industria Richardi Hakluyti Oxoniensis. . . . *Map.* Size 7 × 4. *Presented by Sir Henry Bulwer.* *Paris*, 1587.
[From the Amherst Library.]

Merian, Matthæus.—Topographia Helvetiæ, Rhætiæ, et Valesiæ: Das ist, Beschreibung und Diligentliche Abbildung der Vornembsten Stätte und Plätz in der hochlöblichen Eydgenossschaft Grawbundten, Wallis, und etlicher zugewandten Orten. *Maps, Plans, and Illustrations.* Size 12½ × 8½. *Frankfurt*, 1642.
[From the Holzmann Library.]

Minutoli, Heinrich Freiherr von.—Reise zum Tempel des Jupiter Ammon in der Libyschen Wüste und nach Ober-Aegypten, in den Jahren 1820 und 1821. Size 11 × 9: *Separate Atlas of Illustrations*, size 25 × 19. *Also* 'Nachträge.' . . . [to above work]. *Illustrations.* Size 8 × 5. *Berlin*, 1824–27.

Muller, G. P.—Voyages et découvertes faites par les Russes le long des côtes de la Mer Glaciale et sur l'Océan Oriental, tant vers le Japon que vers l'Amérique. . . . 2 vols. *Map.* Size 6½ × 6. *Amsterdam*, 1766.

Rajal y Larré, Joaquin.—Exploración del territorio de Davao (Filipinas). Size 9½ × 6½. *Presented by the Real Sociedad Geográfica, Madrid.* *Madrid*, 1891.

Robson, Joseph.—An account of six years' residence in Hudson's Bay, from 1733 to 1736, and 1744 to 1747. . . . *Plans.* Size 8 × 5. *London*, 1752.

Roggeveen, Jacob.—Dagverhaal der Ontdekkings-Reis van M. Jacob Roggeveen met de Schepen 'Den Arend,' 'Thienhoven,' en de 'Afrikaansche Galei,' in de jaren 1721 en 1722. . . . Uitgegeven door het Zeeuwsch Genootschap der Wetenschappen. *Map and Illustrations.* Size 9 × 5½. *Middelburg*, 1838.

Schlagintweit, Hermann von.—Reisen in Indien und Hochasien. . . . 4 vols. *Maps and Illustrations.* Size 9 × 6½. *Jena*, 1869–80.

Topley, William.—The geology of the Weald (parts of the counties of Kent, Surrey, Sussex, and Hants). Geological Survey Publication. *Maps, Illustrations, and Sections.* Size 10 × 6½. *London*, 1875.

Velasco, Juan López de.—Geografía y descripción universal de las Indias, publicada. . . . por Justo Zaragoza. Size 9½ × 6½. *Presented by the Real Sociedad Geográfica, Madrid.* *Madrid*, 1894.

Zuallardo, Giovanni.—Il devotissimo viaggio di Gerusalemme. . . . *Maps, Plans, and Illustrations.* Size 9 × 6. *Rome*, 1587.

Switzerland.—Beschreibung der Stadt und Republik Bern. . . . 2 parts. *Maps and Illustrations.* Size 7 × 4½. *Bern*, 1794–1496.
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Itinerariu(m) Germaniæ provincias continens, iis qui iter aliquo vel legationis, vel mercaturæ vel alia ex causa suscipiunt longe necessarium. *Presented by Sir Henry Bulwer.* [N.P., 1587?]
[From the Amherst Library.]

Scheuchzer, Johann Jacob. Nova Helvetiæ tabula geographica, 1712. (Second copy.)

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Artaria's Eisenbahnkarte von Österreich-Ungarn mit Stationsverzeichnis. Vierte Neubearbeitung. X. Auflage. Scale 1:1,500,000 or 1 inch to 23·6 stat. miles. Vienna: Artaria & Co., 1910. *Price* 2.40 *kr. Presented by the Publishers.*

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Geological map of Scotland, reduced chiefly from the Ordnance and Geological Surveys under the direction of Sir Archibald Geikie, K.C.B., D.C.L., F.R.S. Topography by John Bartholomew, F.R.G.S. Scale 1:633,600 or 1 inch to 10 stat. miles. Second edition, with Descriptive Text. Edinburgh: John Bartholomew & Co., 1910. *Price* 7*s.* 6*d. net. Presented by the Publisher.*

This is a new edition.

Denmark. **Kgl. Danske Sökort Arkiv.**

Kort udgivet af det Kongelige Danske Sökort-Arkiv. Nos.: 231, Bornholm med Omgivelser; 232, Guldborg-Sund, Nordlige Del. Copenhagen: Kongelige Danske Sökort-Arkiv, 1909. *Presented by the Danish Admiralty.*

France. **Immanuel.**

Uebersicht der Befestigungen und des Eisenbahnnetzes von Ost-Frankreich. Von Major Fr. Immanuel. Scale 1 : 1,500,000 or 1 inch to 23·6 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1909, Tafel 41. Gotha: Justus Perthes, 1909. *Presented by the Publisher.*

France. **Service Géographique de l'Armée, Paris.**

Carte de France. Scale 1 : 50,000 or 1·3 inch to 1 stat. mile. Sheet XXV.–19, Port-Vendres. Paris: Service Géographique de l'Armée, 1909. *Price* 1.60 *fr. each sheet.*

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ASIA.

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Carte de la Chine Orientale par le Commandant Friquegnon. Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. 9 sheets. Hanoi: Service Geographique de l'Indo-Chine, 1908.

Although this is stated to be a map of Eastern China, it really includes a much wider area than would generally be understood by this title, and in fact extends considerably to the west of Koko Nor; while to the north it takes in a great part of Mongolia, and to the south the whole of Turkey and the north of Siam. A list of authorities consulted is given under the title, from which it will be seen that the surveys and route traverses of all important travellers have been utilized. The map, which is printed in colours, contains a large amount of detail, and care has been taken to distinguish by the style of lettering the relative importance of towns and villages, of which latter an unusual number are shown.

China. **Futterer.**

Holderer's u. Futterer's Expedition in Zentral-Asien 1898–1899. Sektion III. Prof. Dr. Karl Futterer's Routenaufnahme von Min-Tschôu bis Long-Kü-Tsai (Nordwestliches China) vom 1–31 Dezember 1898. Scale 1 : 500,000 or 1 inch to 7·8 stat. miles. 2 sheets. *Petermanns Mitteilungen*, Jahrgang 1909, Tafeln 42 u. 43. Gotha: Justus Perthes, 1909. *Presented by the Publisher.*

Indian Government Surveys. **Surveyor-General of India.**

India and adjacent countries: scale 1 : 1,000,000: 1 sheet, Persia; 1 inch to 1 mile: North-West Frontier Province, 5 sheets; Punjab, 3 sheets; Bombay, 4 sheets; Central Provinces and United Provinces, 8 sheets; Berar Central Provinces and Central India, 7 sheets; Bengal, 1 sheet; Eastern Bengal and Assam, 3 sheets; Burma, 16 sheets.—India, showing railways open and under construction on March 31, 1909. 1 inch to 80 miles.—Bengal Survey, 1 inch to 1 mile, 1 sheet.—Bombay Survey, 1 inch to 1 mile, 1 sheet.—Burma Survey, 1 inch to 1 mile, 6 sheets.—Central India and Rajputana Survey, 1 inch to 1 mile, 1 sheet.—United Provinces: Etah district, 1 inch to 4 miles.—United Provinces Survey, 1 inch to 1 mile, 3 sheets. Calcutta: Surveyor-General's Office, 1909. *Presented by the Secretary of State for India, through the India Office.*

Indo-China. **Gallois.**

Atlas General de l'Indo-Chine Française par Chabert L. Gallois. Hanoi-Haiphong: Imprimerie d'Extrême-Orient, 1909.

This is an interesting and instructive atlas of French Indo-China prepared from the most reliable official documents and surveys. It commences with a short account of the history of the cartography of the region from the earliest times, with facsimiles of the maps of Ptolemy A.D. 1490, Mercator 1538, Ribeiro 1529, Linschoten 1599, P. Alexandre de Rhodes 1650, P. Goos about 1666, and Robert de Vaugondy 1751. After this follow sixty-three plates containing numerous maps and plans of Indo-China as a whole, and separately of its five divisions, Chochurchina, Cambodia, Annam, Tonking, and Laos. The last section of the atlas contains maps of the provinces of China adjacent to French Indo-China. In addition to the maps themselves, relative areas and other statistical information is shown by diagrams. The maps are all printed in colour.

Indo-China—Laos. **Service Géographique de l'Indo-Chine.**

Carte des communications du Laos. Scale 1 : 750,000 or 1 inch to 11·8 stat. miles. 5 sheets. Hanoi: Service Géographique de l'Indo-Chine, 1908.

An outline sketch-map without hills, showing by colours and symbols projected and existing means of communication in the French territory south of Tongking and between the Mekong river and the coast. The extent of the navigability of rivers is also indicated.

Java. **Topographical Bureau, Batavia.**

Spoor en Tramwegkaart van Java en Madoera. Scale 1 : 1,000,000 or 1 inch to 15·7 stat. miles. 2 sheets. Batavia: Topographical Bureau, 1909.

A general map of Java in two sheets, printed in colours, showing means of communication up to date. Enlarged plans of Batavia, Sĕmarang, and Soerabaja are given as insets.

Manchuria.

Die südliche Mandschurei zum Verfolg der Operationen im russisch-japanischen Kriege. Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1909, Tafel 45. Gotha: Justus Perthes, 1909. *Presented by the Publisher.*

AFRICA.

Uganda. **Geographical Section, General Staff.**

Uganda-Congo Commission, 1906–1908. Scale 1: 250,000. 4 sheets. London: Geographical Section, General Staff, 1909. *Price 2s. 6d. each sheet. Presented by the Director of Military Operations.*

AMERICA.

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Standard Topographical map of Canada. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. Sheet 9 S.E. Pembroke, Ontario, and Quebec. Ottawa: Department of the Interior, 1909. *Presented by the Department of the Interior, Ottawa.*

Canada. **Dept. of the Interior, Ottawa.**

Sectional map of Canada. Scale 1 : 190,080 or 1 inch to 3 stat. miles. Sheet 74, Cross lake, revised to September 8, 1909. Ottawa: Department of the Interior, 1909. *Presented by the Department of the Interior, Ottawa.*

Canada. **Dept. of Militia and Defence, Ottawa.**

Topographic map of Canada. Scale 1 : 63,360 or 1 inch to 1 stat. mile. Sheets: 21, Huntingdon, Ontario-Quebec; 22, Laval, Quebec; 23, Lachine, Quebec; 25, Vandreuil, Ontario-Quebec. Ottawa: Department of Militia and Defence: London: Geographical Section, General Staff, 1909. *Presented by the Director of Military Operations.*

United States. **Campbell.**

Kohlenfelder der Vereinigten Staaten. Nach der Karte von Marius R. Campbell, U.S. Geological Survey. Scale 1 : 12,500,000 or 1 inch to 197·3 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1909, Tafel 39. Gotha: Justus Perthes, 1909. *Presented by the Publisher.*

POLAR REGIONS.

Antarctic Regions. **Meinardus.**

Das antarktische Festland. Auf Stielers Handatlas No. 6 nach Bruce, Shackleton u. a. ergänzt von Prof. Dr. O. Meinardus. Scale 1 : 40,000,000 or 1 inch to 631·3 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1909, Tafel 38. Gotha: Justus Perthes, 1909. *Presented by the Publisher.*

GENERAL.

German Colonies. **Sprigade and Moisel.**

Grosser deutscher Kolonialatlas. Bearbeitet von Paul Sprigade und Max Moisel. Herausgegeben von Reichs-Kolonialamt. Ergänzungs-Lieferung 2. Kamerun. Berlin: Dietrich Reimer (Ernst Vohsen), 1909. *Presented by the Publisher.*

The supplementary parts of the German colonial atlas now being issued were noticed in the *Geographical Journal* for August last. The present sheets include the northern part of Kamerun from lat. 5° 25′ N. to Lake Chad.

Portuguese Colonies. **Ministerio da Marinha e Ultramar.**

Atlas Colonial Português. 2a edição reduzida. Lisbon: Ministerio da Marinha e Ultramar. Commissão de Cartographia, 1909. *Presented by the Ministerio da Marinha e Ultramar, Lisbon.*

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during November, 1909. *Presented by the Hydrographer, Admiralty.*

New Charts—No. 3753, Plans on the north coast of Norway: Gi sund, Tiel sund, northern portion, 3*s*. 150, France, south coast: Marseille, 3*s*. 1366, Malacca strait: Penang harbour and approaches, 3*s*. 2991, China, Pechili gulf: Entrance to Liau river, including Newchang, Liau river above Newchang, 3*s*.

Atlantic, North. **U.S. Hydrographic Office.**

Pilot chart of the North Atlantic ocean, December, 1909. Washington: U.S. Hydrographic Office, 1909. *Presented by the U.S. Hydrographic Office.*

Atlantic, North. **U.S. Weather Bureau.**

Meteorological chart of the North Atlantic Ocean, February, 1910. Washington: Department of Agriculture, U.S. Weather Bureau, 1909. *Presented by the U.S. Weather Bureau.*

Atlantic, North, and Mediterranean. **Meteorological Office.**

Monthly meteorological charts of the North Atlantic and Mediterranean, January, 1910. London: Meteorological Office, 1909. *Price 6d. each. Presented by the Meteorological Office.*

Indian Ocean. **U.S. Hydrographic Office.**

Pilot chart of the Indian Ocean, December, 1909, January and February, 1910. Washington: U.S. Hydrographic Office, 1909. *Presented by the U.S. Hydrographic Office.*

Indian Ocean and Red Sea. **Meteorological Office.**

Monthly meteorological charts of the Indian Ocean north of 15° S. lat. and Red Sea, January, 1910. London: Meteorological Office, 1909. *Price 6d. each. Presented by the Meteorological Office.*

Pacific, North. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific Ocean, January, 1910. Washington: U.S. Hydrographic Office, 1909. *Presented by the U.S. Hydrographic Office.*

Pacific, North. **U.S. Weather Bureau.**

Meteorological chart of the North Pacific Ocean, February, 1910. Washington: Department of Agriculture, U.S. Weather Bureau, 1909. *Presented by the U.S. Weather Bureau.*

PHOTOGRAPHS.

China. **Davies.**

One hundred and six photographs of Chê-Chiang, China, taken by Major H. R. Davies, Oxfordshire Light Infantry. *Presented by Major H. R. Davies.*

Major Davies has already presented many photographs taken by him during his extensive travels in China to the Society. Those comprising the present set are of the east coast province of Chê-Chiang, and are carefully arranged and described in an album.

(1) Panorama of Ting-hai harbour; (2) Mouth of Ta-surg Chiang; (3) Inside Nimrod island, Nimrod sound; (4) Citadel hill, Chên-hai; (5) Yü-wang-ssü (Nowang-ssü), between Ch'uan-shan and Ning-po; (6) West end of Yü-wang-Ling (Nowang Ling); (7) Looking west from west end of Yü-wang Ling; (8) View of Chên-hai harbour from Ta-chin-chi Shan; (9) The river at Chên-hai; (10) Descent from K'ung-shu-ling pass; (11) The Nan-ch'ang Hu, near Ning-po; (12) Typical scenery near Ning-po; (13) Typical scenery and hill near Ning-po; (14) Village near Ning-po; (15) Village house near Ning-po; (16) Temple near Ning-po; (17) Big house in village near Ning-po; (18) Ning-po ice house; (19) Water-buffaloes; (20) The Yung Chiang at Ning-po; (21) Sepoy Sher Singh surveying on a grave; (22) Measuring-wheel and Ning-po coolies; (23) Inside Shao-hsing Fu city; (24 and 25) Country near Shao-hsing Fu; (26) Hills near Tou-mên, north of Shao-hsing Fu; (27) Canal near Ts'ao-ê; (28) Cliffs of Niao-mên Shan near Shao-hsing Fu; (29) Wheelbarrow at Ts-ao-ê; (30 and 31) Street in Shao-hsing Fu; (32) Ferry across the Ch'ien-t'ang

Chiang, opposite Hang-chou; (33) View of Grand canal and settlement from British Consulate, Hang-chou; (34) West lake at Hang-chou, from the Ch'ien-t'ang Mên; (35) South-east end of West lake, Hang-chou; (36) South-west end of West lake, Hang-chou; (37) The Lei-fêng-t'a ("Thick" pagoda), Hang-chou; (38) The West lake, Hang-chou; (39) Temples on West lake; (40) European house on West lake; (41) Pass on the way from West lake to Cha-k'ou; (42) View near north suburb, Hang-chou; (43 and 44) View from the Ch'ien-t'ang Mên, Hang-chou; (45) The Ch'ien-t'ang Mên, Hang-Chou; (46) The Wu-lin-Mên water-gate, Hang-chou; (47) Front part of the Wu-lin Mên; (48) The Grand canal in the north suburb, Hang-chou; (49) Canal in Hang-chou city; (50) South wall of Hai-ning Chou; (51) Iron buffalo on sea-wall at Hai-ning Chou; (52) The Hai-ning Chou pagoda; (53–56) The tidal bore at Hai-ning Chou; (57) Kang-sêng-ssŭ and British Consulate, Wên-chou; (58) The Hou Chiang at Wên-chou; (59) Wên-chou anchorage; (60 and 61) Three-span stone arch bridge in Hang-chou; (62) Stone bridge in Hang-chou; (63 and 64) One-span stone arch bridge; (65 and 66) Three-span stone slab bridge; (67) Bridge of boats at Ning-po; (68 and 69) One-span stone slab bridge; (70) Sea-going junk in Yung Chiang at Ning-po; (71 and 72) Sea-going junk in Yung Chiang at Chên-hai; (73 and 74) Ning-po houseboat; (75) Ferry-boat over Ts'ao-ê Chiang at Pai-kuan; (76) Sea-going junk at Pai-kuan; (77) River-boats at Pai-kuan; (78 and 80) Small boat near Ning-po; (79) Foot-boat; (81) Cargo-boat at Shao-hsing Fu; (82) Cargo-boat at Hang-chou; (83–85) Shao-hsing Fu houseboats; (86) Ch'ü-chou houseboat; (87) Lan-sh'i houseboat; (88) "Tobacco"-boat on Ch'ien-t'ang Chiang; (89) "Salt"-boat on Ch'ien-t'ang Chiang; (90) "Rice"-boats on Ch'ien-t'an Chiang; (91) "Wood"-boat on Ch'ien-tang Chiang; (92–94 and 96–100) Boats going over a haulover; (95) Pulling small boat over haulover with boat-hooks; (101–106) Villages of Northern Chê-Chiang.

East Africa Protectorate. **Ross.**

Two photographs of Mount Kenia, taken by W. McGregor Ross, Esq. *Presented by W. McGregor Ross, Esq.*

Two enlargements of excellent telephotographic views of the mountain.

(1) Mount Kenia, 17,040 feet, taken at a distance of twelve miles; (2) Mount Kenia at six miles range, looking south by west.

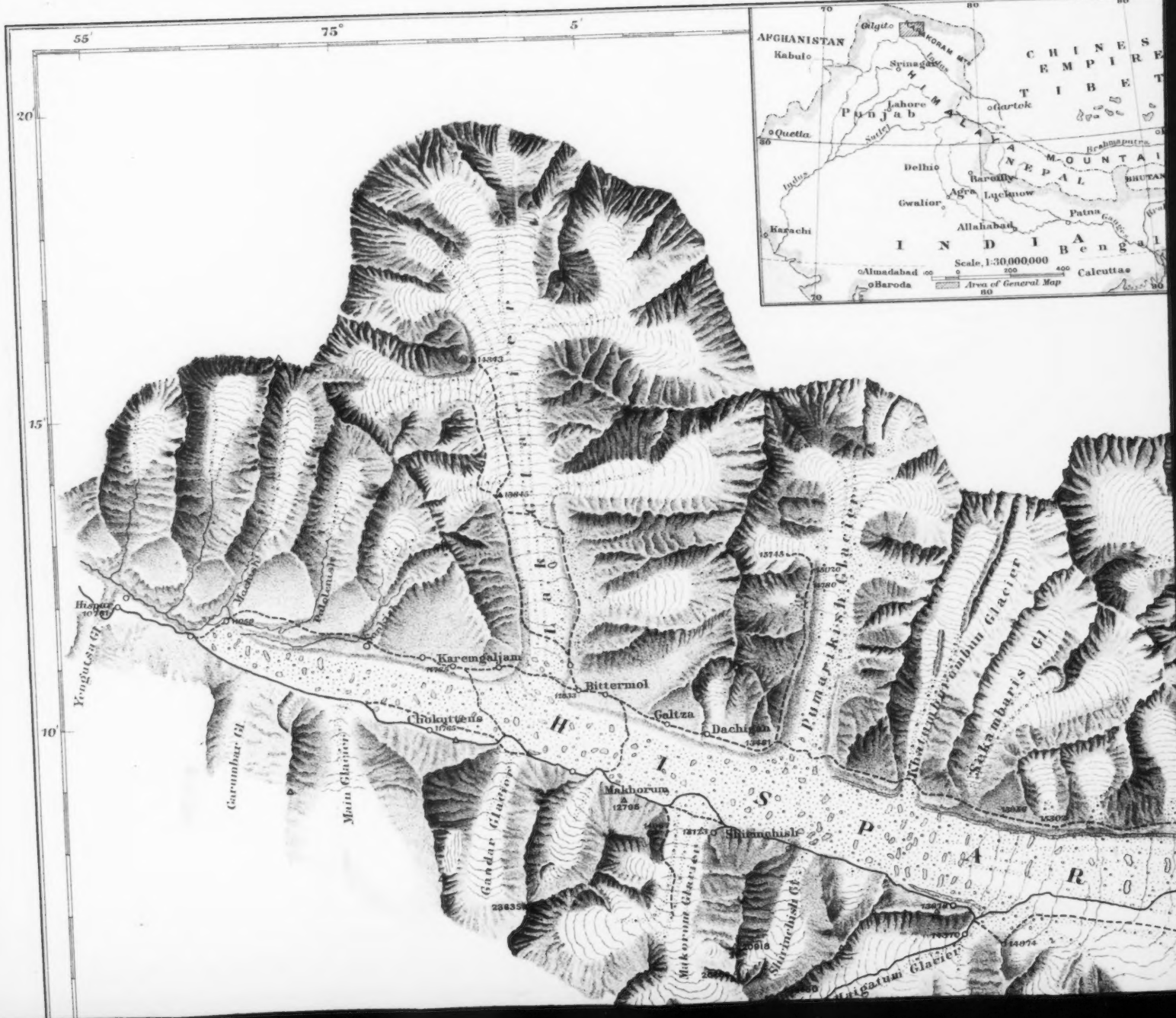
Kashmir and Chinese Turkestan. **Shuttleworth.**

Thirty-nine photographs of Hunza and Chinese Turkestan, taken by Captain A. R. B. Shuttleworth, I.A. *Presented by Captain A. R. B. Shuttleworth.*

Among this set are some good views of glacier and mountain scenery, but perhaps the most interesting are those showing methods of travel and crossing streams by means of improvised bridges.

(1) Mount Rakapushi; (2) Nilt, in Hunza valley; (3) Near Minnipin; (4) A bit of the polo ground at Baltit; (5) The Mirs palace, Baltit; (6) The lower terrace, Chin Bagh; (7) A bit of the road between Baltit and Gulmit; (8) A bit of the Hunza river near Baltit; (9) Suspension bridge over the Hunza river; (10) Pitching camp at Attabad; (11) A bit of the road at Gulmit; (12) Looking towards Pasu; (13 and 14) Temporary bridge, Pasu; (15) The Pasu glacier; (16) The Batur glacier; (17) Beyond Misgat; (18) My tent, Murkhushi, with Mintaka beyond; (19) Mintaka encampment, Taghdumbach Pamir; (20) Mintaka encampment under snow; (21) Paik, Taghdumbash Pamir; (22) Khirgiz yort, Paik; (23) Tashkurgan; (24) Sarikoli and Kashgari, Tashkurgan; (25 and 26) Mustagh-ata from Tashkurgan; (27) Transport on the road between Tashkurgan and Tarbashi; (28) Climbing up the Darstart gorge; (29) Getting started, Tarbashi; (30) Moving off, Tarbashi; (31–33) Temporary bridge over Kintol; (34) Crossing the Kintol; (35) Main street, Yang-i-Hissat; (36) Bird's-eye view of Kashgar from the top of the western gate; (37) The Swedish Mission Hospital, Kashgar; (38) The Hazrat Apak, Kashgar; (39) The back of the British Consulate, Kashgar.

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.


55'
75°
5'
20'
15'
10'
Yengutsa Gl.
Hispar
Hispar
Karemgaljam
Bittermol
Choktattenis
Garumbar Gl.
Main Glacier
Gandar Glacier
Makhorum
Shimshisl
Makorum Glacier
Shirinchisl Gl.
Chogatum Glacier
Dachigam
Galtza
Pumarikish Glacier
Khatungpiyarumbun Glacier
Sakamharis Gl.
H I S P A R
Indus
Satlej
Brahmaputra
Ganges
Jamna
Delhi
Bareilly
Agra
Lucknow
Gwalior
Patna
Allahabad
Karachi
Ahmadabad
Baroda
Calcuttas
Lahore
Quetta
Kabul
Srinagar
Leh
Gilgit
Kohat
Kartok
AFGHANISTAN
CHINESE EMPIRE
TIBET
NEPAL
BHUTAN
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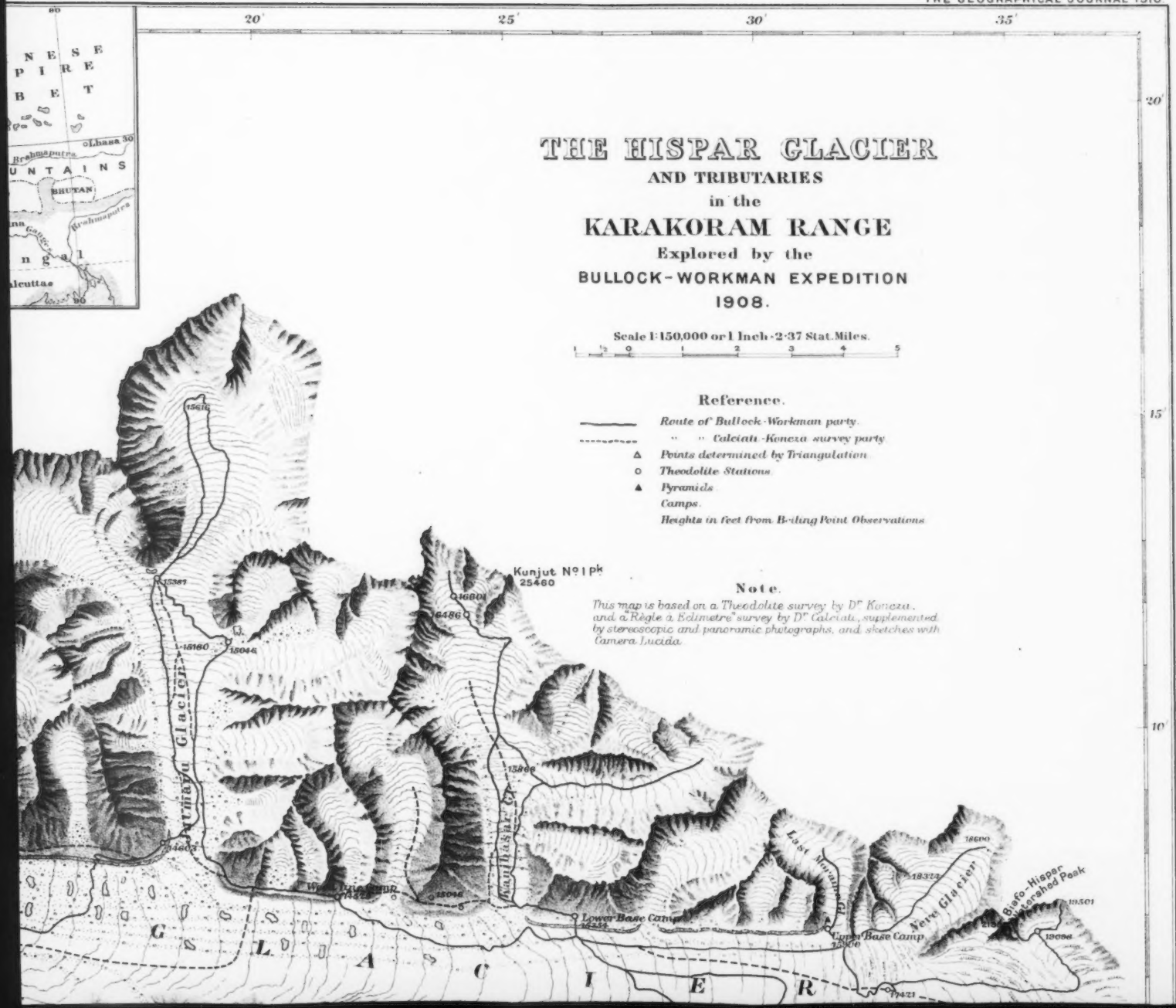
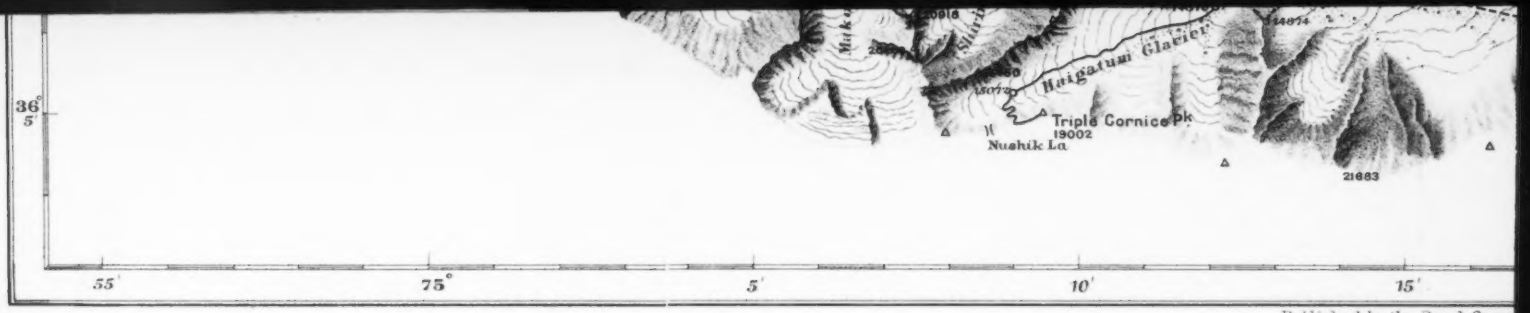
Bengal
Scale, 1:30,000,000
Area of General Map


20'
25'
30'
35'
20'
15'
10'
THE HISPAR GLACIER
AND TRIBUTARIES
in the
KARAKORAM RANGE
Explored by the
BULLOCK-WORKMAN EXPEDITION
1908.
Scale 1:150,000 or 1 Inch=2·37 Stat. Miles.
1 ½ 0 1 2 3 4 5
Reference.
Route of Bullock-Workman party.
" " Calciati-Konoza survey party.
Points determined by Triangulation.
Theodolite Stations.
Pyramids.
Camps.
Heights in feet from Boiling Point Observations.
Note.
This map is based on a Theodolite survey by Dr Konoza, and a "Règle a Eclimetre" survey by Dr Calciati, supplemented by stereoscopic and panoramic photographs, and sketches with Camera Lucida.
Kunjut No 1 pk
25460
16601
16486
15616
15387
15180
15046
13866
Yarmanda Glacier
Kunjut Glacier
Lower Base Camp
Upper Base Camp
East Kunjut Gl.
Nerve Glacier
Biafo-Hispar Watershed Peak
18610
18374
19501
19088
17421
G L A C I E R



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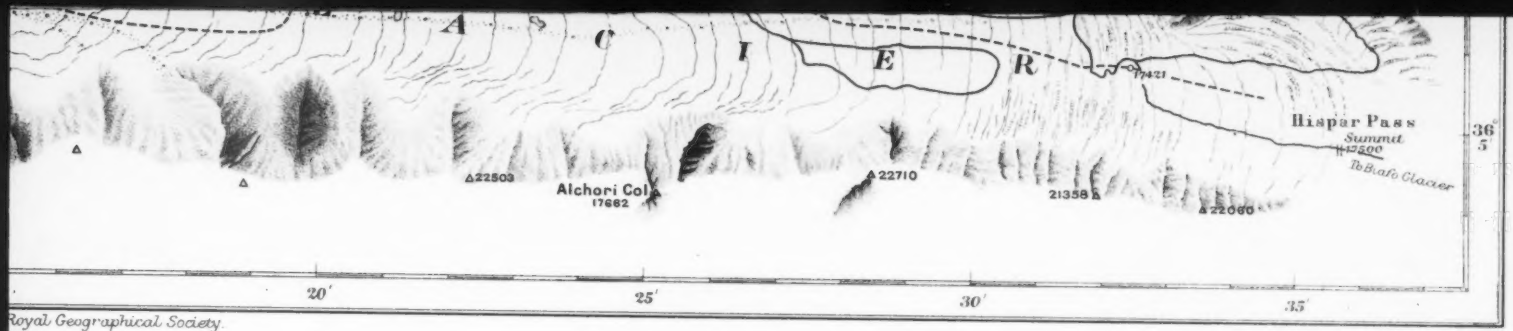

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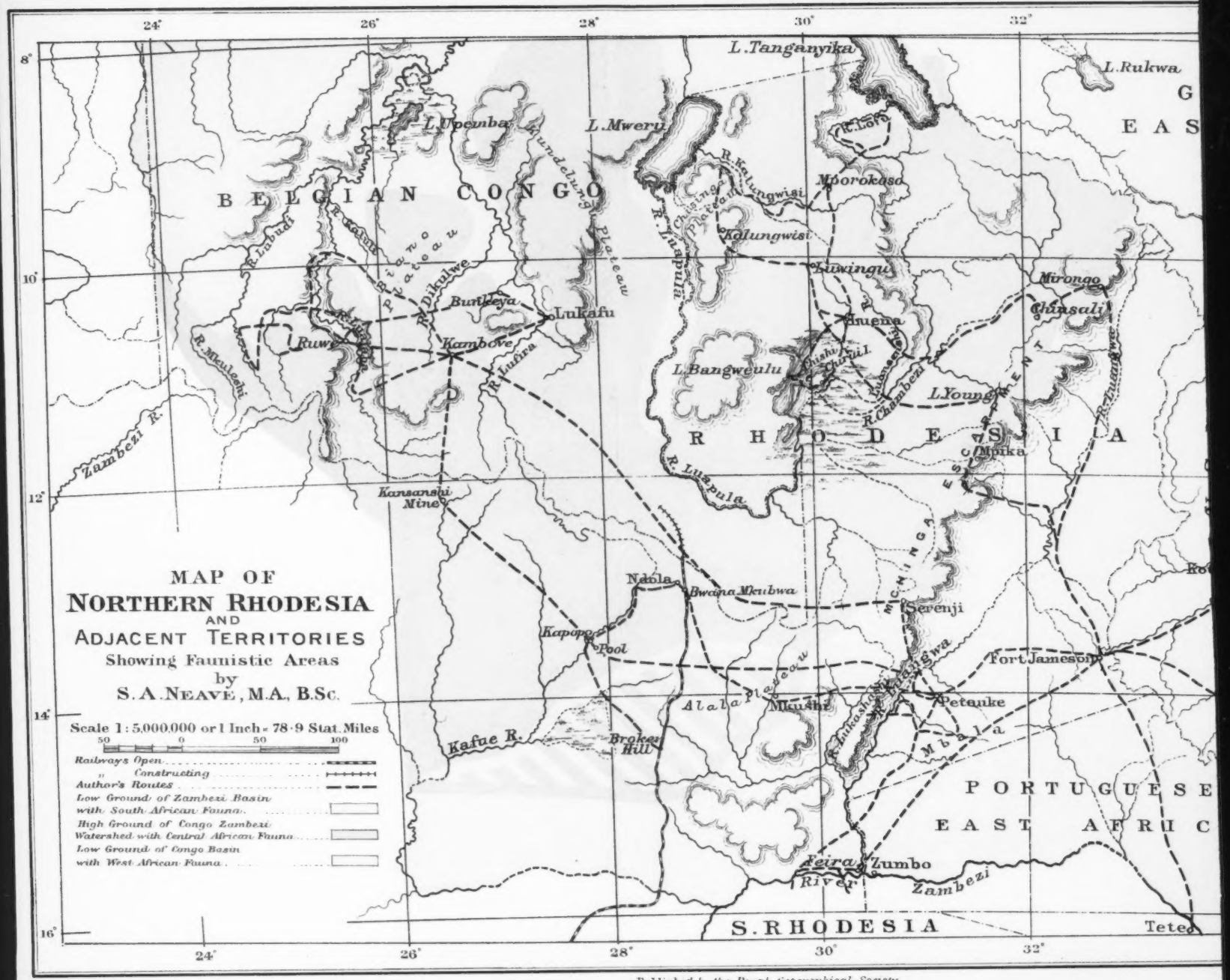

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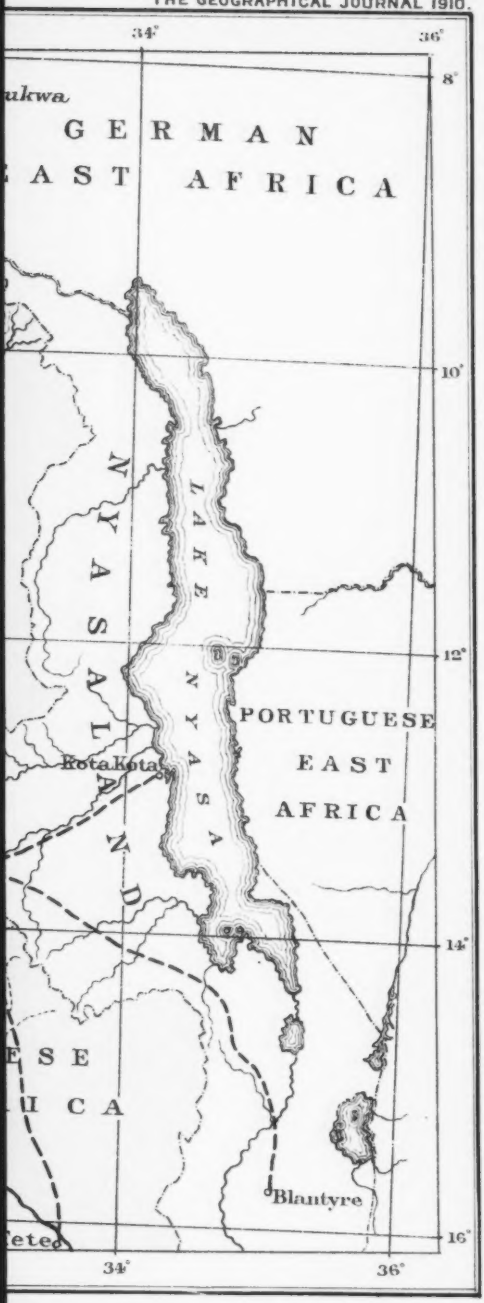
34°
36°
8°
10°
12°
14°
16°
ukwa
GERMAN
AST AFRICA
NYASALAND
LAKE NYASA
PORTUGUESE
EAST
AFRICA
Kota Kota
Blantyre
34°
36°